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Diabetes risk evaluation using the Indian Diabetes Risk Score (IDRS) and its correlation with BMR, visceral fat and insulin resistance in semi-urban population

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Abstract

The Indian Diabetes Risk Score (IDRS) is a validated tool for identifying individuals who are at high risk of developing type 2 diabetes mellitus (T2DM) in the future. Basal metabolic rate is the amount of energy your body uses to rest and relax after a good night's sleep without any exercise in a neutral environment. Excess visceral fat has been linked to reduced insulin sensitivity at cellular level and has been hypothesized to give rise to insulin resistance. The study aims to determine the association of the risk of Diabetes with BMR, Visceral fat and Insulin resistance among the Semi – Urban residents. A total of 202 healthy individuals in the age group of 20 – 55 years of both genders who underwent Master health checkup in a tertiary care hospital were recruited for the study. IDRS score was compiled using age, waist circumference, physical activity and family history of diabetes. BMR was calculated using Mifflin-St Jeor predictive equation. Visceral fat was measured using body composition analyzer. Insulin resistance (HOMA-IR) was calculated using fasting insulin and glucose values. Using the IDRS for risk assessment 41.08% had low risk (<30), 40.09% had moderate risk (30-50) and 18.81% had high risk (≥60). IDRS was found to be positively correlated with BMI, Body Fat, Visceral Fat, Body Age, Insulin Resistance, Fasting Blood glucose, HbA1c and LDL. 59% of the participants were categorized as having moderate and high risk of developing T2DM based on IDRS. IDRS score was higher in women. IDRS increased with risk factors such as high BMI, visceral fat, dysglycemia and insulin resistance.

Keywords: Visceral fat, BMR, Insulin Resistance, IDRS

Full-length article **Corresponding Author*, e-mail: *renukap@srmist.edu.in*

1. Introduction

By 2035, there will be 592 million people worldwide living with diabetes, up from 382 million in 2013, as per the International Diabetes Federation (IDF). IDF predicts that more than 65 million people worldwide have diabetes, and that number will rise to 109 million by 2030 in India alone [1]. Since Diabetes is becoming more common and affects people of all ages, including teenagers, kids, and women who are pregnant are more likely to have the condition. Indian diabetes risk score (IDRS), a simple and affordable screening tool, was created as a result of research to help identify people who are at risk so that timely introduction of appropriate lifestyle interventions can prevent and delay the outbreak of the illness in the region and nation as a whole. The Indian Diabetes Risk Score (IDRS), created by the Madras Diabetes Research Foundation (MDRF), is an easy-to-use tool for estimating a person's risk of developing diabetes based on factors like age, waist circumference, level of physical activity and family history of the disease. It is a comprehensive risk score for recognizing previously undiagnosed diabetes individuals. A total score of 100 was used to categorize the individuals as high risk (scoring >60), moderate risk (score 30–50), and low risk (score <30) [2]. The use of IDRS has been demonstrated to be an effective tool in numerous studies conducted nationwide and among various ethnic groups [3]. Early detection of those with underlying DM is crucial because it allows them to control the condition early on and improves quality of life by delaying the onset of severe complications. Numerous screening techniques are advised according to the WHO and other medical institutions, including the National Institute for Health and Clinical Excellence (NICE), the Centers for Disease Control and Prevention. These comprise risk assessment instruments and biochemical assessments such as urine glucose, random blood glucose, fasting plasma glucose, glycated hemoglobin (HbA1c), and the 75-gram oral glucose tolerance test (OGTT) [4].

Late diagnosis and delay in initiation of therapy contribute to the under identification of co-morbidities associated with Diabetes and the result in mortality. This can be largely avoided by detecting diabetes mellitus (DM) early and raising awareness of the condition among the general public and medical professionals. Physical activity was found to reduce the chance of diabetes by modifying several risk factors, i.e., body mass index (BMI), blood pressure, inflammation and insulin sensitivity. The prevalence of type 2 diabetes is thought to be rising as a result of the worldwide obesity pandemic since patients with type 2 diabetes are typically overweight or obese. The basal metabolic rate (BMR) is the smallest amount of energy

required to carry out all biological processes while at rest and in a steady state. BMR is a major factor in the energy balance as it accounts for the majority of human energy expenditure. The expression "thermal production" or "oxygen consumption per unit body mass" are frequently used. In order to manage daily energy balance in diabetic patients, BMR is crucial for calculating the daily energy content (kCal or kJ) of meals during lifestyle interventions like dietary modification and exercise protocols [5]. In recent years, there has been a drop in exercise, followed by an increase in sedentary behaviors and the deterioration of eating habits, which can lead to an increase in the risk of acquiring metabolic disorders such as diabetes mellitus. T2DM causes high glucose levels in the bloodstream due to diminished glucose utilization, which leads to the development of the atypical metabolic processes in skeletal muscle, the liver, and adipose tissue are linked to IR in diabetics. Microvascular and macrovascular complications are linked to undiagnosed diabetes. Identification and therapy of type 2 diabetes at an early stage are likely to decrease morbidity and mortality [6]. Visceral fat (VF) accumulation may contribute to the etiology of suppressed insulin sensitivity, according to several lines of evidence. Therefore, VF excess has been connected to decreased free fatty acid (FFA) re-esterification rate, diminished response to insulin quantitated by the euglycemic insulin clamp technique, and enhanced resistance of lipid breakdown to insulin's opposing effect in both visceral and peripheral adipocytes [7]. There is paucity of literature correlating BMR, Visceral fat and Insulin resistance with the Indian Diabetes Risk Score to identify individuals at risk for development of Diabetes Mellitus. Hence, this study aims to investigate the risk assessment of Diabetes Mellitus using Indian Diabetes Risk Score among the healthy semi-urban community and correlating with BMR, Visceral fat and Insulin resistance.

2. Materials and Methods

This is a cross-sectional study conducted among the individuals attending the Master Health Check-up in SRM Medical Hospital and Research Centre at an age group of 20-55 years. The study protocol was followed in accordance with the approval of the Institutional Ethics Committee. (SRMIEC-ST0722-06) and informed written consent was obtained from all subjects. The sample size was calculated by using the formula: $n= 4pq/d^2$, where, n = Sample size, p= prevalence (33.1%), q= 100-p, d= 20% precision. The sample size is 202 based on the prevalence 33.1% determined in another study [8]. Apparently healthy non-diabetic individuals between 20 – 55 years were included in the study. Patients already diagnosed with Diabetes, PCOS and other endocrine disorders like hypo or hyperthyroidism were excluded from the study. The following information and measurements were obtained from the participants of the research:

a) Demographic characteristics: age, sex, family history of diabetes.
b) Anthropometric measurements: Height was measured by stadiometer; Weight was measured by mass scales and waist circumference (WC) and hip circumference quantified by measuring tape.
c) Indian Diabetes Risk Score (IDRS): 4 parameters: age, WC, physical activity and history of diabetes in family. Each parameter has been assigned score from 0 to 60 and accordingly the subject was graded as having ≤ 30 - Low risk, 30 – 50 - Moderate risk or ≥ 60 - High risk.
d) Basal Metabolic Rate (BMR) was calculated by using the Mifflin-St Jeor predictive equation in T2DM.

Men: 10 x weight (kg) + 6.25 x height (cm) – 5 x age(y) + 5.
Women: 10 x weight (kg) + 6.25 x height (cm) - 5 x age(y) - 161.

e) Body impedance analysis (BIA) is a quick and simple non-invasive body composition evaluator. It was calculated by using Body Composition Analyzer. Omron HBF 214 Full Body Composition Monitor. Parameters measured are Body fat, Visceral fat, Muscle % and Body Age.
f) BMI was calculated by using the formula: (Weight[kg]/Height[m]²)

Reference range for Asians [9]

<18.5 - Under weight
18.5 to 23.9 - Normal weight
23.0 to 24.9 - Overweight
>25.0 - Obese

2.1. Biochemical investigations

6 ml of blood was collected from the participants in fasting state following aseptic precautions in different vacutainers. Fasting plasma glucose by Hexokinase method, Total cholesterol by Cholesterol oxidase method, Triglycerides by Enzymatic GPO, HDL-C and LDL- C by Direct antibody inhibition method, these parameters were analyzed by Beckman coulter AU480 auto analyser. HbA1C by HPLC method in BIO RAD D10 analyzer and Insulin by Enhanced CLIA in VITROS Eci immuno analyzer.

2.2. Statistical methods

Data will be analysed using Statistical Package for Social Services (SPSS 22.0). A p value < 0.05 shows a significant difference. Continuous variables mentioned as Mean ± SD for Gaussian distributed data. Student's t-test: to compare the difference in mean levels of analysed biochemical parameters. Pearson's correlation and One- Way ANOVA were used for correlating and comparison of means in more than 2 groups.

3. Results

In this study, 202 healthy participants were included. Out of 202 individuals 50% were males and 50% were females. 53.9% were 20-29 years, 23.2% were 30-39 years, 14.3% were 40-49 years and 8.41% were 50-55 years. 31.68% of individuals follow a sedentary lifestyle without any physical activity, 49% are moderately active with regular exercise or strenuous work and 19.3% are highly active with regular exercise and strenuous work. Around 55.44% has no family history, 33.66% had one diabetic parent and both parents were diabetic for 10.89% participants. Using IDRS for assessment of Diabetes mellitus (Table 1), 41.08% had low risk (≤30), 40.09% had moderate risk (31-50) and 18.81% had high risk (≥60). There was a statistically significant difference between a. Low-risk and c. High-risk participants with respect to age, BMI, systolic and diastolic blood pressure, waist circumference, hip circumference, body fat, visceral fat, body age, fasting plasma glucose, HbA1c and insulin resistance. a. Low-risk and b. Moderate-risk don't have statistically significant differences (Table 2). There was a significantly higher IDRS in female than compared to males. As expected, HDL levels were higher in women. Body fat %, visceral fat and BMR were higher in males when compared to women (Table not shown).

Table 1: Indian Diabetes Risk Score groups of the study participants

Parameters	**n (202)**	**%**
IDRS		
Low risk ≤30	83	41.08%
Moderate risk 31-50	81	40.09%
High risk ≥60	38	18.81%

Table 2: Comparison of parameters among Low risk, Moderate risk and High risk based on IDRS

Parameters	**Low risk (n=83)**	**Moderate risk (n=81)**	**High risk (n=38)**	**probability**
Age (years)	27.59±8.04	29.33±9.04	43.36±9.53	0.000***[a, c]
Height (m)	1.65±0.09	1.78±1.24	1.62±0.07	$0.468_{(NS)}$
Weight (kg)	63.96±14.66	66.91±14.14	75.76±14.39	0.000***[a, c]
BMI (kg/m^2)	23.47±4.81	24.71±5.09	28.78±5.13	0.000***[a, c]
Systolic Blood Pressure (mmHg)	109.63±8.75	111.72±10.34	120.52±16.75	0.000***[a, c]
Diastolic Blood Pressure (mmHg)	79.87±7.07	81.48±6.54	85.26±7.61	0.001**[a, c]
Waist circumference (cm)	80.48±9.79	83.61±10.41	93.46±9.95	0.000***[a, c]
Hip circumference (cm)	87.61±9.89	91.61±10.88	100.62±10.69	0.000***[a, c]
Body Fat	31.02±11.40	33.69±10.34	39.48±8.14	0.000***[a, c]
Visceral Fat	9.28±5.36	5.37±0.32	13.44±5.61	0.000***[a, c]
Body Age	40.89±14.17	46.02±13.60	52.92±11.22	0.000***[a, c]
Muscle%	28.09±5.84	28.40±6.37	28.46±7.21	$0.126_{(NS)}$
BMR (Cal/day)	1434.83±327.42	1467.61±215.39	1443.62±228.50	$0.851_{(NS)}$
Fasting plasma glucose (mg/dl)	90.77±8.21	93.20±9.17	99.43±9.86	0.000***[a, c]
HbA_{1C}%	5.32±0.37	5.37±0.32	5.85±0.45	0.000***[a, c]
Insulin Resistance	1.81±1.29	1.93±1.45	2.74±2.44	0.009**[a, c]
Total Cholesterol (mg/dl)	164.19±34.60	167.96±26.35	177.39±41.38	$0.127_{(NS)}$
Triglycerides (mg/dl)	100.44±56.42	104.32±60.96	112.86±35.85	$0.518_{(NS)}$
HDL-Cholesterol (mg/dl)	45.20±12.16	44.71±8.36	47.02±8.96	$0.509_{(NS)}$
LDL-Cholesterol (mg/dl)	115.10±28.13	117.01±24,98	128.28±27.75	0.039**[c]

** $p < 0.05$: significant, *** $p < 0.001$: Highly significant

Table 3: Correlation of IDRS with anthropometric measures and biochemical parameters

PARAMETERS	r Value	p Value
BMI	0.495[b]	0.000***
Body Fat	0.355[b]	0.000***
Visceral Fat	0.386[b]	0.000***
Body Age	0.371[b]	0.000***
Muscle %	0.082	0.248(NS)
BMR	0.039	0.578(NS)
Insulin Resistance	0.250[a]	0.000***
Fasting plasma glucose	0.348[b]	0.000***
HbA1c	0.494[b]	0.000***
Total Cholesterol	0.168[a]	0.017**
LDL	0.208[a]	0.003**

a Correlation Small (0.3 to 0.1)
b Shows strongest correlation (0.5 to 0.3)
c Indicates highly significant (1.0 to 0.5)

** $p < 0.05$: significant, *** $p < 0.001$: Highly significant, ^{NS} Not Significant

Table 4: Correlation between BMR with Biochemical Parameters of Moderate risk and High risk individuals based on IDRS

Parameter	Moderate risk		High risk	
	r Value	p value	r Value	p value
Fasting plasma glucose	0.492	0.000***	0.133	0.427$^{(NS)}$
Insulin Resistance	0.358	0.001**	-0.090	0.590$^{(NS)}$
BMI	0.430	0.000***	0.538	0.001**
Visceral Fat	0.681	0.000***	0.538	0.000***

IDRS was found to be positively correlated with BMI, Body Fat, Visceral Fat, Body Age, Insulin Resistance, Fasting Blood glucose, HbA1c and LDL (Table 3). BMR of moderate risk individuals showed highly significant correlation with visceral fat, fasting plasma glucose, Insulin Resistance and BMI. In high risk individuals, BMR showed siginficant correlation only with visceral fat and BMI (Table 4).

4. Discussion

The current study involved the participation of 202 individuals recruited to evaluate the risk of developing diabetes mellitus using the Indian Diabetic Risk Score. This score includes two modifiable (physical activity and waist circumference) and two non-modifiable (age and family history of DM) risk factors to compute the score. Around 40% of the participants were in the moderate IDRS and only 18.81% in the high-risk group with a score over 60. Compared to our study, higher number of participants were categorized into the moderate risk group according to studies by Chowdhury et al (46%). Mohan et al (50.3%), Bhatia et al (68%), Subramani et al (75%) [10] [11] [12] [13] and Patil et al (54.6%) [14]. Some of the above studies also recorded a higher percentage of population with IDRS score above 60 (12.1% to 37%). The differences in the risk computed between our study and the others could be due to the variation in the lifestyles of the study population.

Our study consisted of equal representation from both genders. The overall IDRS score was higher in women compared to men (42.33 ± 17.41 vs 33.18 ± 16.82). More women were categorized in the moderate and high-risk group of IDRS compared to men. In a study by urban Haryana population, Arora et al,[15] identified similar findings in contrast to Misra et al [16] from Delhi who found no statistically significant association based on gender. Relatively, younger age group (20-34 years) individuals were found to have a moderate-high risk based on IDRS in contrast to various studies which demonstrate that risk of diabetes mellitus increases with age [17][18]. The higher prevalence of risk of diabetes mellitus among younger age adults could be attributed to the sedentary lifestyle and unhealthy eating habits.

Nearly 45% of the present study group have a family history of diabetes. A positive family history has been shown to be a strong and independent risk factor for the development of diabetes [19]. Adhikari et al, demonstrated that nearly 80% of South Indian children who develop T2DM have a family history of DM [20]. About 32% of our study group maintained a sedentary lifestyle with higher percentage of moderate to highly active individuals belonging to the low-risk category. Our results are in concurrence with findings of other population indicating that the risk of T2DM can increase if the recommended time of moderate exercise of < 150 minutes per week is not met [21][22].

Inclusion of modifiable risk factor, waist circumference in IDRS substantiates its role as an important factor in prediction of T2DM risk. 26% of females (waist circumference >80cm) and 16% of males (waist circumference >90cm) from our study had higher abdominal obesity. Similar findings have been reported from studies conducted not only in India but other countries as well [23][24][25]. Comparison of low, moderate and high risk IDRS groups revealed a statistically significant difference in fasting plasma glucose, BMI, HbA1c, insulin resistance and visceral fat. The high-risk group had higher glucose levels, HbA1c, insulin resistance, BMI and visceral fat. A cross-sectional study from urban slum of Pune noted 43% of participants had a capillary glucose value between 110 and 140 mg/dl and that of 5% individuals crossed 140mg/dl. Similarly, 60% of high risk of IDRS subjects had glucose level above 140mg/dl in a study by Mohan et al [26].

Increase in IDRS correlated significantly with BMI, body fat, visceral fat, fasting plasma glucose, insulin resistance, HbA1c, total cholesterol and LDL cholesterol indicating that the score is a cost-effective method to identify diabetes mellitus risk among the Indian population. Significant number of studies have validated the use of this score for utility at the community level [27][28][29]. In moderate risk IDRS category, BMR showed positive correlation with BMI, visceral fat, fasting plasma glucose and insulin resistance (HOMA IR) whereas in high risk IDRS category, BMR showed significant positive correlation only with BMI and visceral fat. Traditionally, it has been accepted that obesity is the result of imbalance between energy intake and energy expenditure. Daily energy expenditure is the combination of basal energy expenditure (BEE), diet induced thermogenesis (DIT) and activity energy expenditure (AEE). About 50-75% of the total energy expenditure is accounted for by the resting energy expenditure (REE) which is mainly determined by body composition especially fat free mass (FFM). Skeletal muscle, bone, organs with high metabolism such as liver, brain, intestine, heart and kidney form the fat free mass. REE is affected by changes in the body composition.

Numerous studies have shown that resting energy expenditure is higher in obese individuals even after adjusting for fat free mass due to difference in the fat mass compartment [30]. Sampath et al [5] demonstrated a significant positive correlation between BMR and fasting glucose, insulin resistance, BMI and visceral fat in diabetic subjects with peripheral neuropathy. Visceral adipose tissue is more responsive to noradrenaline, increased blood flow and resistance to the antilipolytic action of insulin. Underlying inflammation and cytokine production along with increased reactive oxygen species production, mitochondrial disruption had been implicated in excess heat generation and hyper metabolism [31].

5. Conclusion

In our study, 59% of the participants were categorized as having moderate and high risk of developing T2DM based on IDRS. IDRS score was higher in women. IDRS increased with risk factors such as high BMI, visceral fat, dysglycemia and insulin resistance. Though there is a significant positive influence of BMR on body mass index and visceral fat in moderate and high risk IDRS, further exploration of its role in the risk prediction of T2DM is warranted.

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