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Risk Assessment of Type-2 Diabetes Mellitus using Canadian Risk Questionnaire

Saini Sahil[1], Shandilya Kapil[1], Kumar Harish[1], Singh Tarun[1], Dagar Wandeep[1], Kaur Parneet[1], Sharma Varruchi[2], Sharma Aanchal[3], Sharma Anil Kumar[4]* and Gupta Ajay Kumar[4]

[1]M.M. College of Pharmacy, Maharishi Markandeshwar (Deemed To Be University), Mullana, Ambala (Haryana), India
[2]Department of Biotechnology and Bioinformatics, Sri Guru Gobind Singh College, Sector 26, Chandigarh 160019, India
[3]University Centre for Research and Development, University Institute of Biotechnology Chandigarh University, Gharuan, Mohali, India
[4]Department of Bio-Sciences and Technology, Maharishi Markandeshwar (Deemed To Be University), Mullana, Ambala (Haryana), India

**Corresponding Author*

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Abstract: Type 2 Diabetes Mellitus (T2DM) is a disease that manifests itself gradually and over time. Diabetes detection at an early stage is critical for delaying the disease progression. The Canadian Risk (CANRISK) questionnaire, with slight modifications, was used to determine who is the most at risk of getting diabetes mellitus. Therefore, a prospective observational study has been conducted in community nearby Maharishi Markandeshwar Institute of Medical Sciences and Research (MMIMSR), Mullana (Ambala, India). A total of 200 subjects (140 males and 60 Females) were enrolled by using CANRISK (with slight modifications) which includes parameters like Body mass index (BMI), waist circumference, genetics, smoking, alcohol consumption, physical activity etc., out of which 51(25.5%), 71(35.5%) and 78(39%) were found at low, moderate and high risk, respectively. A post counselling assessment was done after promoting healthy lifestyle and enhancing awareness among them about obesity, physical activity, smoking cessation and stopping alcohol consumption. It was observed that 40.5%, 31.5% and 28% subjects were at low, moderate and high risk, respectively.

Keywords: T2DM, CANRISK, Obesity, Physical activity, Smoking cessation, Alcohol consumption

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Introduction

India has majority number of diabetic cases earning it the title "diabetes capital of the world". Diabetic cases are estimated to rise from 42 million to 69.9 million by 2025 (Mohan *et al.*, 2007). Diabetes is expected to significantly reduce both long - term survival and life quality in India (Syn *et al.*, 2021). In rural and urban India, increasing modernization, low physical activity, and harmful dietary habits have all had an impact on the general public health (Flatt *et al.*, 2023). Early detection of individuals at risk (Table 1), as well as appropriate management in the form of losing weight, dietary changes (US Preventive Services Task Force, 2021), and increased physical activity, could significantly aid in the prevention, or at least postponement, of the onset of diabetes (Huang *et al.*, 2023).

Evidence demonstrates that early detection of diabetes through proper screening techniques, particularly in participants at higher risk for diabetes (Scanlon *et al.*, 2019), can support to divert or defer cardiovascular events, lowering the disease's diagnostic and therapeutic, social, and economic costs. There is also evidence that pre-diabetic intervention benefits diabetes diagnosis (Hu *et al.*, 2023).

Type 2 diabetes Mellitus (*T2DM*):

Type 2 diabetes, which accounts for nearly 90-95% of all diabetes cases, elderly describe as non-insulin-dependent diabetes (NIDDM) or adult-onset diabetes. It is distinguished by insulin resistance and relative insulin deficiency (Szatko *et al.*, 2020). These people need not require insulin injections to survive, at least initially, and frequently throughout their lives. The main contributor to insulin resistance in type 2 diabetes mellitus, is obesity (Hare and Topliss, 2022). The American Diabetes Association recommends screening overweight children and adolescents for type 2 diabetes (Sameer *et al.*, 2019). Insulin resistance in type 2 diabetes mellitus patients raises insulin demand in insulin-target tissues (Liu *et al.*, 2021; San-Millian, 2023). Aside from insulin resistance, the increased demand for insulin was not met by pancreatic beta cells due to defects in their function (Wu *et al.*, 2021). Insulin secretion, on the other hand, decreases with increased insulin demand over time due to the gradual damage of beta cells (Amanat *et al.*, 2020). This could cause some type 2 DM patients to go from being self-sufficient to becoming insulin-dependent (Kaul *et al.*, 2023). One of the primary distinctions among type 1 or type 2 diabetes is insulin dependence (Horvath *et al.*, 2007; Mohd Ghozali *et al.*, 2022).

Materials and Methods

Study design: Prospective observational study in the community

Study Duration: Six months

Study Setting: Maharishi Markandeshwar Institute of Medical Sciences and Research (MMIMSR), Mullana

Subjects and methods: Early detection of Type-2 Diabetes mellitus with data collection

Study methodology: Protocol based study and statistical evaluation of data

Inclusion criteria:

- People of age group between 35 -70 years
- Both male and female subjects

Exclusion Criteria:

- People of age group less than 35 years and more than 70 years
- People who are already suffering from diabetes
- People who are not willing to participate in the study

Assessment Parameters:

- Body mass index (BMI)
- Waist circumference.
- Genetics History
- Physical activity.

Table 1: Risk factor of type 2 diabetes mellitus

Risk Factors	
1. Acquired risk factor	• Age • Family history
2. Environmental risk factor	• Body mass index (BMI) • Stress • Physical inactivity • Obesity • Cardiac disease • Unhealthy diet • Insulin resistance • Urbanisation • Smoking

Table 2: Gender wise distribution of Subjects with Age Groups (n=200)

Age group (In years)	Male	Female	Total
35-40	42	14	56
41-55	38	29	67
56-65	41	11	52
66-70	19	6	25
Grand total	140	60	200

Results

In this study, a total of 200 subjects participated comprising of 140 male subjects and 60 female subjects (Table 2). In the age group of 30-35 years, total subjects were 56 out of which 42 were male participants and 14 were females. In age group 41-55 years, total subjects were 67 out of which 38 were male subjects and 29 were females. In age group 56-65 years, total subjects were 52 out of which 41 were male participants and 11 were females. In age group 66-70 years, total subjects were 25 out of which 19 were male participants and 6 were females. The majority of candidates were from the age group of 41-55 years (Table 2).

In this study we observed 103 subjects (out of 200) whose waists were (less than 37 inches males and less than 31.5 inches in females). There were 41 males and 46 females out of 87 who were in the range between 37-40 inches /between 31.5-35 inches, respectively. 10 subjects i.e., 5 males and 5 females their waists fall in the category of Over 40 inches /Over 35 inches (Table 3).

In the present study we observed 89 subjects i.e. 24 female and 65 male (out of 200) whose BMI fall in the category of 25-29.There were 6 females and 15 males out of 21 who were in the range of 30-34. 3 subjects i.e., 1 female and 2 males whose BMI fall in the category of 35 and over (Table 4). 87 subjects (29 females and 58 males) comes under the range of BMI less than 25.

In this study we observed 63 subjects (out of 200) who did exercise. There were 44 males and 19 females out of 63 (Table 5). Out of 200 volunteers, 96 males and 41 female subjects did

Table 3: Categorization of subjects according to Waist circumference criteria (n=200)

Criteria (in inches)	Male	Female	Grand total
Less than 37 inches / Less than 31.5 inches	94 (47%)	9 (4.5%)	103(52.5%)
Between 37-40 inches /Between 31.5-35 inches	41(20.5%)	46 (23%)	87 (43.5%)
Over 40 inches /Over 35 inches	5 (2.5%)	5 (2.5%)	10 (5%)
Grand total	140 (70%)	60 (30%)	200

Table 4: Categorization of subjects according to BMI criteria (n=200)

BMI	Female	Male	Grand Total
BMI 25-29	24 (12%)	65 (32.5%)	89 (44.5%)
BMI 30-34	6 (3%)	15 (7.5%)	21 (10.5%)
BMI 35 and over	1 (0.5%)	2 (1%)	3 (1.5%)
BMI less than 25	29 (14.5%)	58 (29%)	87 (43.5%)
Grand Total	60 (30%)	140 (70%)	200

Table 5: Categorization of subjects according to Physical Activities criteria (n=200)

Physical activity	Male	Female	Grand Total
No	96 (48%)	41 (20.5%)	137 (68.5%)
Yes	44 (22%)	19 (9.5%)	63 (32.5%)
Grand Total	140 (70%)	60 (30%)	200

Table 6: How often do the subjects eat green vegetables or fruits

Vegetable and fruit consumption	Male	Female	Grand total
Everyday	32 (16%)	9 (4.5%)	41 (20.5%)
Not everyday	108 (54%)	51(25.5%)	159 (79%)
Grand Total	140 (70%)	60 (30%)	200

not exercise (i.e., 137 subjects).

In our study, we found 41 subjects (out of 200) who consume vegetables and fruits daily (Table 6). There were 32 males and 9 females out of 41. Out of 200 volunteers, 108 males and 51 female subjects who did not consume vegetable and fruit everyday (i.e., 159 subjects).

In this study, we found 71 subjects (out of 200) i.e. 22 female and 49 male who have been told by a doctor or nurse that you have high blood pressure or have you ever taken high blood pressure pills (Table 7). Out of 200 volunteers, 91 males and 38 female (129 total) subjects did not ever been told by a doctor or nurse that you have high blood pressure or have you ever taken high blood pressure pills.

In the current study, we found 42 subjects (out of 200) i.e. 12 females and 30 males who ever been found to have high blood sugar either from blood test, during an illness, or during pregnancy (Table 8). Out of 200 volunteers, 110 males and 48 females (158 total) subjects who did not ever been found to have high blood sugar either from blood test, during an illness, or during pregnancy.

Table 7: Subjects having high blood pressure and/or taking high blood pressure pills

High blood pressure	Female	Male	Grand Total
No/ Don't know	38 (19%)	91(45.5%)	129(64.5%)
Yes	22 (11%)	49 (24.5%)	71 (35.5%)
Grand Total	60 (30%)	140 (70%)	200

Table 8: Subjects having high blood sugar either confirmed from blood test, during an illness, or during pregnancy

High blood sugar	Female	Male	Grand Total
No/Don't know	48 (24%)	110 (55%)	158(79%)
Yes	12 (6%)	30 (15%)	42 (21%)
Grand Total	60 (30%)	140 (70%)	200

Table 9: Females given birth to a large baby weighing 4.1 kg or more

Birth to large baby	Female	Male	Grand Total
No/Don't know	58 (29%)	0 (0%)	58 (29%)
Yes	2 (1%)	0 (0%)	2 (1%)
Grand Total	60 (30%)	0 (0%)	60 (30%)

In the present study, we found 2 subjects (out of 200) i.e. 2 females who ever given birth to a large baby weighing (4.1 kg) or more while 58 females out of 200 subjects didn't ever given birth to a large baby weighing (4.1 kg) or more (Table 9).

In this study, we found 9 subjects (out of 200) i.e. 2 females and 7 males whose relatives (brother and sister) have ever been diagnosed with diabetes (Table 10). Furthermore, we found 1 male subject out of 200 whose relatives (children) have ever been diagnosed with diabetes. Out of 200 subjects, 37 subjects i.e. 12 females and 25 males whose relatives (Father) have ever been diagnosed with diabetes. Moreover, 25 subjects out of 200 i.e. 16 females and 9 males whose relatives (Mother) have ever been diagnosed with diabetes. 106 subjects out of 200 i.e. 25 females and 81 males whose relatives does not have ever been diagnosed with diabetes. In the last category, we found 22 subjects (out of 200) i.e., 5 females and 17 males whose relatives (others) have ever been diagnosed with diabetes.

In our study, we found 55 subjects (out of 200) i.e. 17 females and 38 males who have completed their high school diploma level of education. Furthermore, we found 32 subjects out of 200 i.e.,10 females and 22 males who have completed some college or university level of education (Table 11). Out of 200 subjects, 101 subjects i.e. 27 females and 74 males who have completed some high school or less level of education. Moreover, 12 subjects out of 200 i.e. 6 females and 6 males who have completed university or college degree level of education.

In this study we observed 134 (78 males and 56 females) volunteers (out of 200) who never smoked (Fig. 1). Out of 200 subjects, 66 subjects

Table 10: Relatives of subjects ever been diagnosed with diabetes

Relatives diagnosed with diabetes	Female	Male	Grand Total
Brothers/Sisters	2 (1%)	7 (3.5%)	9 (4.5%)
Children	0 (0%)	1 (0.5%)	1 (0.5%)
Father	12 (6%)	25 (12.5%)	37 (18.5%)
Mother	16 (8%)	9 (4.5%)	25 (12.5%)
No/Don't know	25 (12.5%)	81 (40.5%)	106 (53%)
Others	5 (2.5%)	17 (8.5%)	22 (11%)
Grand Total	60 (30%)	140 (70%)	200

Table 11: Level of education in males and females

Education level	Female	Male	Grand Total
High school diploma	17 (8.5%)	38 (19%)	55 (27.5%)
Some college or university	10 (5%)	22 (11%)	32 (16%)
Some high school or less	27 (13.5%)	74 (37%)	101 (50.5%)
university or college degree	6 (3%)	6 (3%)	12 (6%)
Grand Total	60 (30%)	140 (70%)	200

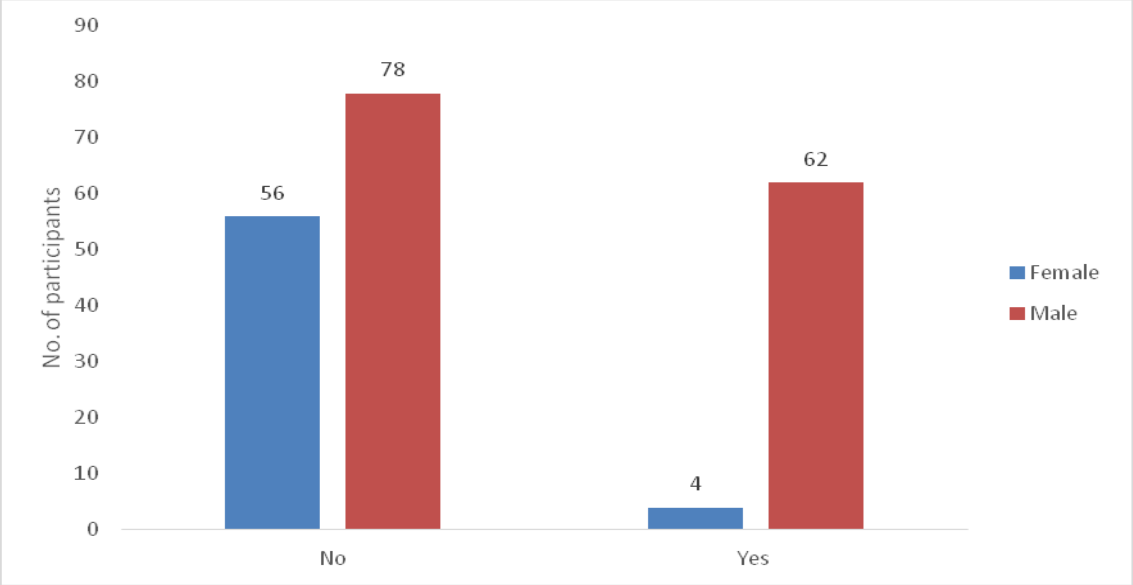

Fig. 1: Categorization of subjects according to smoking criteria.

used to smoke out of that 62 were males and 4 were females.

In this study we observed 133 (76 males and 57 females) subjects (out of 200) who never consumed alcohol (Fig. 2). Out of 200 subjects, 64 males and 3 females used to consume alcohol (i.e. 67 subjects).

In this study it was found that total male subjects were 140 and female subjects were 60. It was concluded that 71 subjects (out of 200) i.e., 21 females and 50 males fall under the category of 'Moderate Risk'. While 78 subjects (out of 200) i.e., 15 females and 63 males fall under the category of 'High Risk'. 51 subjects (out of 200) i.e., 24 females and 27 males have fall under the category of 'Low Risk' category (Table 12).

Comparison of risk score before and after follow up:

According to the questionnaire in the current

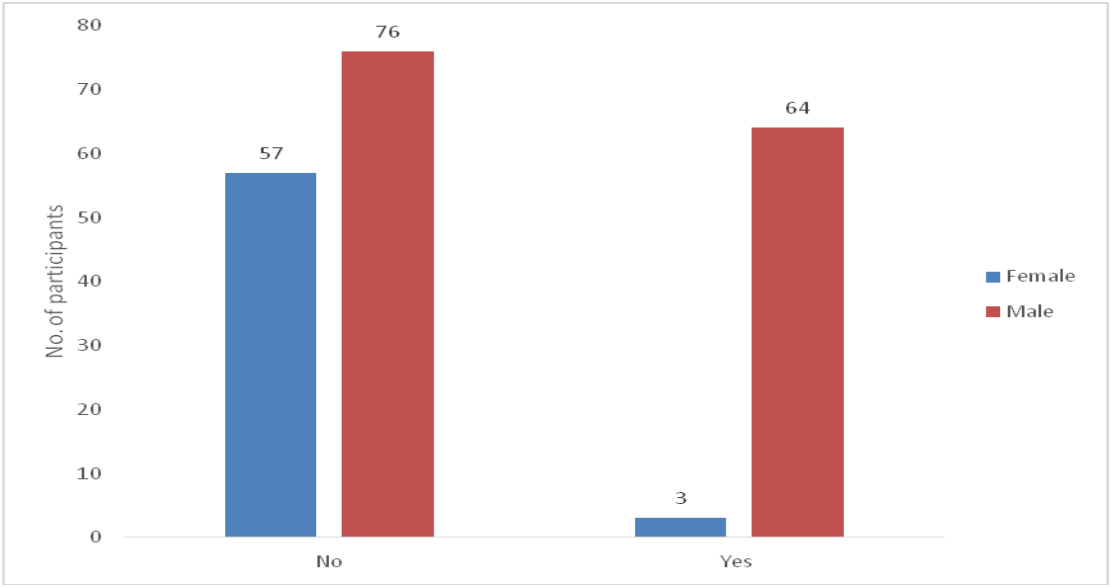

Fig. 2: Categorization of subjects according to alcohol consumption criteria.

Table 12: Categorization of subjects according to risk

Risk	Female	Male	Grand Total
21-32 - Moderate Risk	21 (10.5%)	50 (25%)	71 (35.5%)
33 and over - High Risk	15 (7.5%)	63 (31.5%)	78 (39%)
Lower than 21- Low Risk	24 (12%)	27 (13.5%)	51 (25.5%)
Grand Total	60 (30%)	140 (70%)	200

Table 13: Showing number of subjects in each risk group in initial assessment

Risk score	Males	Females	Total
Low (less than 21)	52.9% (27)	47 % (24)	25.5% (51)
Moderate (21-32)	70.4% (50)	29.5% (21)	35.5% (71)
High (33 and over)	80.7% (63)	19.2% (15)	39% (78)
Grand total	70% (140)	30% (60)	100% (200)

Table 14: Showing number of subjects in each risk group in follow up assessment

Risk score	Males	Females	Total
Low (less than 21)	59.25% (48)	40.75% (33)	40.5% (81)
Moderate (21-32)	80.9% (51)	19% (12)	31.5% (63)
High (33 and over)	73.2% (41)	23.8% (15)	28 % (56)
Grand total	70% (140)	30% (60)	100% (200)

study, in the preliminary assessment, nearly 25.5% population were assessed as low risk, 35.5% as moderate risk, and 39% as high risk (Table 13).

After two months, a follow-up was taken and 40.5% were found in low-risk category, 31.5% were found in moderate risk category and 28% were found in high-risk category (Table 14).

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Total Score	30.74	200	14.593	1.032
	Follow Up Score	26.76	200	12.443	0.880

Paired Samples Correlations

		N	Correlation	Significance One-Sided p	Significance Two-Sided p
Pair 1	Total Score & Follow Up Score	200	0.963	<.001	<.001

ANOVA

		Sig.
Total Score	Between Groups	0.004
	Within Groups	
	Total	
Follow Up Score	Between Groups	0.005
	Within Groups	
	Total	

Table 15: Statistical analysis of data

In our study we have used statistical analytical test to check out the difference between the value of initial risk percentage vs follow up risk percentage and we conclude the value that there is significant difference between both values. We have used pair sample statistics, paired sample correlation and ANOVA test.

The results show the p-value is less than 0.001 showing very strong evidence against the null hypothesis, we reject the null hypothesis that there is a significant difference between Group 1 and Group 2 (Table 15).

The result shows, the p-value is less than 0.05, we reject the null hypothesis that there's a significant difference between Group 1 (calculated total score during study) and Group 2 (score calculated Follow-up).

Discussion

Type 2 Diabetes Mellitus is a lifelong condition with severe complications that dramatically increase mortality and morbidity. Diabetes is spreading at an increasing rate around the world. Diabetics are expected to rise from 171 million in

2000 to 366 million by 2030. T2DM awareness among the Indian population is still very low, and the disease's prevalence is increasing due to urbanization, the adoption of an unhealthy lifestyle, and possible genetic susceptibility. Some risk factors exist before the development of type 2 diabetes mellitus. Early detection of these risk factors can slow down the progression of the disease.

Using questionnaire, this study sought to identify participants at low risk, moderate risk, and high risk of developing type 2 diabetes mellitus. All the questions of questionnaire were found to be effective predictors of overall score for type 2 diabetes mellitus risk assessment. Amongst them age, BMI, waist circumference, consumption of fruits and green vegetables every day, genetic correlation, smoking and alcohol consumption were best predictors for assessing risk. At the time of the initial assessment, 51 (25.5%) of the 200 subjects were considered to be at low risk, 71 (35.5%) were known to be at moderate risk, and 78 (39%) were considered to be at high risk of getting type 2 diabetes mellitus. So, intervention like lifestyle changes were suggested to them such as brisk walking, weight reduction, smoking cessation and limit/ avoid alcohol consumption. Following that, a follow-up was performed, and 81 (40.5%) were classified as low risk, 63 (31.5%) as moderate risk, and 56 (28%) comes under the category of high risk. This shows that lifestyle changes are effective in slowing down the progression of type-2 diabetes mellitus.

As a result, appropriate screening tools are required to aid in diabetes prediction and to ensure greater prevention efforts, and the government should launch programmes to enhance awareness and knowledge regarding type 2 diabetes mellitus and its consequences.

Conclusion

In our study, out of 200 subjects, 25.5% (51) were found at low risk, 35.5% (71) were at moderate risk, and 39% (78) comes under the category of high risk of developing T2DM in the initial assessment. Therefore, lifestyle changes were suggested to them. Thereafter two months, a follow up assessment was done and 40.5% (81), 31.5% (63) and 28% (56) were found at low, moderate and high risk for developing T2DM, respectively.

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