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The Efficacy of Risk-Assessment Score for Early Screening of Diabetes Mellitus Among Bangladeshi Adults

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***Abstract*- The chronic metabolic disorder diabetes mellitus (DM) is a fast-growing global problem with huge social, health, and economic consequences. Studies support the utilization of risk-assessment scoring systems in quantifying individual's risk for developing T2DM. Thus, using a simple risk-assessment scoring system for early screening of T2DM among Bangladeshi adults will be beneficial to identify the high-risk adults and thus taking adequate preventive measures in combating diabetes. The aim of the study is to evaluate the efficacy of a risk-assessment scoring system for early screening among Bangladeshi adults for developing T2DM. A cross-sectional observational study was carried out to evaluate the efficacy of risk-assessment scoring system in the outpatient department (OPD) of Medicine, Barishal Medical College & Hospital, Barishal, Bangladesh from June 2020 to November 2020 among randomly sampled 323 adult Bangladeshi male and female subjects. With written informed consent, the Finnish Diabetes Risk Score (FINDRISC) questionnaire was used to collect the data including demographic characteristics and different risk factors. In this study, both non-modifiable and modifiable risk factors showed statistically significant association with the FINDRISC among Bangladeshi adults($p<0.05$). Among 323 subjects, a total of 28.12% had slightly elevated diabetes risk score (DRS). A total of 16.05% had moderate DRS and 8.48% had very high DRS. There was a significant association among FINDRISC with history of previous high blood glucose, and treated hypertensive Bangladeshi adults. This study predicts that 24.53% of the Bangladeshi adults may develop moderate to high risk T2DM within the consecutive 10 years. This study clearly demonstrates that FINDRISC scoring system can work reasonably well as screening tool, detecting undiagnosed T2DM in the general population. People with high risk of DM should be referred for early intervention and changes to a healthy lifestyle and primary prevention to prevent or delay the onset of T2DM.The findings may help the health care professionals to substantiate the possible improvement in glucose metabolism and lifestyle changes, and better convince people at high risk of T2D to take action towards healthier lifestyle habits.**

***Keywords:*- Diabetes mellitus, FINDRISC, Risk-assessment score, early screening, prevention.**

I.INTRODUCTION

Diabetes is a chronic, metabolic disease characterized by elevated levels of blood glucose (or blood sugar), which leads over time to serious damage to the heart, blood vessels, eyes, kidneys and nerves. The classical class ification of diabetes as proposed by the American Diabetes Association (ADA) in 1997 as type 1, type 2, other types, and gestational diabetes mellitus (GDM) is still the most accepted classification and adopted by ADA[1].

The most common is type 2 diabetes, usually in adults, which occurs when the body becomes resistant to insulin or doesn't make enough insulin. With an increasing incidence and economic burden, type 2 diabetes mellitus (DM) has been a significant public health concern world wide. Diabetes mellitus (DM) affects around 8.3% of world's adult population, and World health organization has predicted the total number of cases of DM to rise from 371 million in 2012 to 552 million in 2030 [2].

According to the International Diabetes Federation (IDF), approximately 415 million adults between the ages of 20 to 79 years had diabetes mellitus in 2015.[3] DM is proving to be a global public health burden as this number is expected to rise to another 200 million by 2040[4].It has grown fast in low and middle-income countries over the past decade. The International Diabetes Federation (IDF) estimates, Bangladesh has nearly 8.4 million of diabetic patients which is expected to reach to 16.8 million by 2030[5].This condition exerts a pernicious effect on patient health and health care budgets, and early detection of subjects with undiagnosed diabetes might be important in reducing the burden of diabetic complications.

In Bangladesh most of the patients are type 2 diabetics and the risk of developing type 2 diabetes mellitus (T2DM) is determined by some modifiable factors related to rapid urban growth and changing lifestyle (i.e. obesity, sedentary lifestyle, diet, smoking, physical and emotional stress) and non-modifiable factors (i.e. family history of diabetes, age, race/ethnicity).[6,7]

The rising prevalence of T2DM in Bangladesh is primarily attributed to rapid urbanization and associated changes in lifestyle, such as sedentary lifestyle, higher calorie food intake and stressful life.[8,9] Prevention of diabetes is important because it is costly both in human and monetary matters.[10] Awareness of risk factors is a prerequisite to prevent diabetes among general population and also in high-risk groups, such as impaired fasting glucose (IFG) and impaired glucose tolerance (IGT).[11-13] The benefits of early detection and intervention on improved health outcomes and reduced morbidity associated with T2DM are shown in many studies.[14, 15]

Major risk factors identified for DM can be used to guide screening strategies, preventive interventions and health policy development.[16] The benefits of early detection and intervention on improved health outcomes and reduced morbidity associated with T2DM are shown in many studies.[17–21] Studies also support the utilization of risk-assessment scoring systems in quantifying individual's risk for developing T2DM.[22–26]

As the prevalence of DM among Bangladeshi adults rises prediction of new cases of T2DM in Bangladesh requires early identification and screening. Studies also support the utilization of risk- assessment scoring systems in quantifying individual's risk for developing T2DM. [27] Thus, using a simple risk-assessment scoring system for early screening of T2DM among Bangladeshi adults will be beneficial to identify the high-risk adults and thus taking adequate preventive measures in combating diabetes.

II. OBJECTIVE

The objective of the study is to evaluate the efficacy of a risk-assessment scoring system for early screening among Bangladeshi adults for developing T2DM in a selected local hospital in Barishal, Bangladesh.

III. METHODOLOGY

1. Design

A cross-sectional observational study was carried out to evaluate the efficacy of risk-assessment scoring system among adults in Barishal.

2. Setting, sample size and inclusion & exclusion criteria:

The cross-sectional observational study was carried out in the outpatient department (OPD) of Medicine, Barishal Medical College & Hospital, a government run hospital in Barishal, Bangladesh from June 2020 to November 2020 among randomly sampled 323 adult Bangladeshi male and female subjects. Subjects undiagnosed with diabetes mellitus and had previous history of high blood glucose during pregnancy or other health examination (i.e. impaired fasting glucose, impaired glucose tolerance or gestational diabetes mellitus) were included. Individuals with an apparent communicative, cognitive impairment or physical disability were excluded from the study. With written informed consent, the Finnish Diabetes Risk Score (FINDRISC) questionnaire was used to collect the data including demographic characteristics and different risk factors.

3. Calculation of FINDRISC:

Various risk factors of T2DM were reviewed from the literature like sex, age at diagnosis, ethnicity, family history of diabetes, diet and exercise, smoking and alcohol usage, hypertension, hyper lipidaemia, body mass index (BMI), weight, waist circumference (WC), gestational diabetes, macrosomia and polycystic ovarian syndrome. [28]

Various risk-assessment scoring systems were reviewed like American Diabetes Association[29], Rotterdam [30], Cambridge [31], Finnish [32], Danish [33], Indian [34], Thai [35], Omani [36], Kuwaiti [37], Australian T2DM risk-assessment tool[38] and Trinidad Risk Assessment Questionnaire-5 (TRAQ-5)[39]From a review of literature regarding risk factors of developing DM in Oman, the Finnish Diabetes Risk Score (FINDRISC) developed in 2001 and tested on Finnish population and in different countries. [32,40–44] In Bangladesh, still we do not have any diabetes risk assessment scoring system. After review of literature regarding risk factors of developing diabetes in Bangladesh,

we also reviewed some other well validated risk assessment scoring systems for diabetes of different countries. We found the risk assessment tools of the Finnish Diabetes Risk Score (FINDRISC) [32] to calculate risk score was more useful for the Bangladeshi adults. The FINDRISC had 8 risk factors correlating with the risk of developing T2DM and was used as a prognostic screening tool to detect a diabetes risk in a 10-year period based on age, family history, WC, BMI, physical activity, vegetable/fruit diet, past history of hypertension and blood glucose.

It demonstrates the probability of developing T2DM within 10 years and the risk score is categorized as <7: low (estimated 1 in 100 will develop DM), 7–11: slightly elevated (estimated 1 in 25 will develop DM), 12–14: moderate (estimated 1 in 6 will develop DM), 15– 20: high (estimated1 in 3 will develop DM) and >20: very high

(estimated1 in 2 will develop DM). Hence, the FINDRISC tool was found to be appropriate for the purpose of this study.

4. Components of FINDRISC tool:

Anthropometric measurements of height and weight were measured by a reliable height scale and weighing scale, respectively. Fasting blood glucose (FBG) ≥126 mg/dL (7 mmol/L) was diagnosed using laboratory blood glucose test. [33,45]

BMI (weight in kilograms/square of height in metres (kg/m2)) was categorized as underweight (≤18.5 kg/m2), normal (BMI: 18–25 kg/m2), overweight (BMI: 25–30 kg/m2) and obese (BMI: ≥30 kg/m2). Hypertension was defined as a systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥ 90 mmHg, or in case of use of anti-hypertensive medications was measured by a manual sphygmomano meter in standard conditions (measured 3 times after a 5-min rest between each measurement).[46]

WC ≥94 cm (39 inches) for males and ≥80 cm (35 inches) for females was considered as a risk factor for DM,[47] and it was measured in a horizontal plane, midway between the inferior margin of the ribs and the superior border of the iliac crest using a reliable measuring inch tape.

5. Statistical analysis:

Data were entered into Statistical Packages for Social Sciences (SPSS) version 20 for comparing, analysis and auditing for accuracy. Data were screened for missing values, logical inconsistencies and extreme values. There was no missing data. The means and standard deviations were used to describe continuous data. For categorical data, frequencies and percentages were estimated. Among the basic characteristics of the study subjects, the continuous variables were compared with each other using the Student's t-test. Categorical variables were compared with each other using the chi-square test. P value <0.05 was considered as significant.

IV. RESULTS

1. Demographic and clinical characteristics:

Total 323 subjects, both male and female were included in the study. Majority of them were below 45 years (81.4%). Maximum age was 75 years and minimum was 19 years. Among them male and female were 71.8% and 28.2%, respectively. Waist circumference was about 52.3% for men: <94 cm and women: <80 cm. Some of the subjects were married (40.2%) and had a family history (grand parents, parents, uncles, aunts, cousins, siblings; 33.9%) of diabetes mellitus ($p<0.05$). Some of them had high BMI (30.9% were overweight and 9.7% were obese); ($p<0.05$).

A total of 38.4% of the adults had no daily physical activity and low consumption of vegetables, fruits or berries (30.6%); ($p<0.05$). A total of 28.6% of the adults had hypertension and were on anti-hypertensive medications and 25.4% had previous history of high blood glucose ($p<0.05$). [Table I & II]

2. Risk assessment scoring (FINDRISC) among Bangladeshi adults:

A total of 28.12% of the Bangladeshi adults had slightly elevated diabetes risk score (DRS). Among them majority were male. Among all adults 16.05% had moderate DRS and 8.48% had very high DRS. This predicts that 24.53% of the Bangladeshi adults may develop moderate to high risk T2DM within the consecutive 10 years, if no primary preventive measures are taken to restraint it. [Figure I & II]

V. DISCUSSION

With the rapid transition in economic development, industrialization and globalization have led to lifestyle changes and increase in life expectancy in most areas of the world. This increase in cultural and lifestyle changes, including unhealthy dietary habits and decrease in physical activity, has been accompanied by an increase in the prevalence of non-communicable (chronic) diseases, including DM[48].

Diabetes mellitus (DM) affects around 8.3% of world's adult population.[49] This increase in the cases of DM may be due to high prevalence and low incidence of the disease, the rising prevalence of overweight and obesity, lack of physical activity, and changes in the demographic characteristics of the population.[50] Type 2 diabetes mellitus is often asymptomatic at its onset and can remain undiagnosed for several years until complications appear.

This condition forms a large burden to the patients, their families, and the healthcare system.[51,52] Therefore, early detection of subjects with diabetes is important in reducing the burden of diabetes complications.[53] However, it is impossible for public health administrations to screen for diabetes in general population. Measuring the blood glucose level after a 2-h oral glucose tolerance test (OGTT) has been the recommended method to identify subjects with asymptomatic diabetes.

However, it is an invasive procedure and costly and time-consuming when used on a large scale. Screening could be more efficient if targeted at subjects with high risk for type 2 diabetes.[54] FINDRISC is a useful tool for identifying people with asymptomatic DM who might not seek early or regular evaluation, thus facilitating intervention early in the disease course. Early detection leads to a better quality of life, reduced morbidity, premature mortality and ultimately a reduction in associated health care and wider economic costs.

Adults with slightly elevated high risk assessment score, regardless of their blood glucose status, are suitable candidates for lifestyle modification.

The health care professionals can empower the patients in the moderate-high risk group to be self-motivated with life

Table 1. Demographic and clinical characteristics among Bangladeshi adults (N=323).

Demographic and clinical and characteristics		Frequency (N)	Percentage (%)
Age (years)	< 45 Years	263	81.4
	45-54 Years	36	11.2
	55-64 Years	14	4.6
	> 65 Years	9	2.8
Family history of diabetes mellitus	No	181	56.1
	Grand Parent, aunt, uncle, or first cousin	90	27.8
	Parent, sibling , children	52	16.1
BMI (kg/m2)	Normal: Lower than 25kg/m2	192	59.4
	Over weight: 25-30 kg/m2	100	30.9
	Obese: Higher than 30 kg/m2	31	9.7
Waist cirumference (cm)	Men: <94 cm and women: <80 cm	169	52.3
	Men: 94-102 cm and women: 80-88 cm	132	40.9
	Men: >102 cm and women: >88 cm	22	6.8
Physical activity daily 30 min	Yes	199	61.6
	No	124	38.4
Vegetables, fruit or berry consumption	Every day	224	69.4
	Not every day	99	30.6
History of hypertension and/or anti-hypertensive	No	231	71.4
	Yes	92	28.6
History of high blood glucose	No	241	74.6
	Yes	82	25.4
Fasting blood glucose	<7 mmol/L	222	68.7
	>7 mmol/L	101	31.3
Blood pressure	<140/90 mmHg	215	66.6
	>140/90 mmHg	108	33.4
Gender	Male	232	71.8
	Female	91	28.2
Marital Status	Single	193	59.8
	Married	130	40.2

style modifications like increasing physical activity, maintaining ideal body weight and periodic health checks, including blood glucose and blood pressure. This should prompt high-risk adults with knowledge acquisition on prevention, early detection, treatment and disability limitation in prevention of DM leading to quality care.[55,56] A high dietary fiber and increase in vegetable consumption, low-moderate total calorie, reduced fat, low glycaemic index foods and low polyunsaturated fat will reduce the susceptibility to DM.[57]

At least 30 min of moderate physical activity with variable emphasis on high-intensity and resistance training exercise (e.g. brisk walking, swimming, cycling, dancing) on all or most days of the week are recommended. Regular walking for at least 30 min per day reduces diabetes risk by 35%"40%. [58] This has been proven to effectively prevent and delay the development of DM among young adults.[59]

In this study, the non-modifiable risk factors i.e. age, positive family history of diabetes, history of hypertension or blood glucose were the significant independent risk factors for predicting T2DM. However, BMI, WC, physical activity and dietary intake were the significant modifiable risk factors. Both non-modifiable and modifiable risk factors were statistically significant with the FINDRISC among Bangladeshi adults ($p<0.05$). Hypertension is a major risk factor for atherosclerosis and diabetes.[60] An increase in blood pressure is significantly associated with diabetes, particularly among urban-dwellers than rural areas.[61]There was a significant association of FINDRISC with history of hypertension and previous history of high blood glucose among the Bangladeshi adults.

In Bangladesh, prevalence of diabetes in adults is 6.9%, [62] with significant predictors like age, hypertension, obesity/WC/BMI and family history. In this study, among all adults 16.05% had moderate DRS and 8.48% had very high DRS. This predicts that 24.53% of the Bangladeshi adults may develop moderate to high risk T2DM within the consecutive 10 years, if no primary preventive measures are taken to restraint it. This assessment will help to increase awareness and motivate the public about the importance of modifiable anthropometric risk factors regarding T2DM.[63]

A high dietary fiber and increase in vegetable consumption, low- moderate total calorie, reduced fat, low glycaemic index foods and low polyunsaturated fat will reduce the susceptibility to DM. At least 30 min of moderate physical activity with variable emphasis on high-intensity and resistance training exercise (e.g. brisk walking, swimming, cycling, dancing) on all or most days

of the week is recommended. Regular walking for at least 30 min per day reduces diabetes risk by 35%−40%.[64,65]

Table II: Association of risk factors of Finish Diabetes Score among Bangladeshi adults. (N=323)

FINDRIC Risk Assessment Factors		λ value	df	p
Age (years)	< 45 Years	42.742	6	<0.001
	45-54 Years			
	55-65 Years			
	> 64 Years			
Family history of Diabetes Mellitus	No	61.695	6	<0.001
	Grand Parent, aunt, uncle, or first cousin			
	Parent, sibling , children			
BMI (kg/m^2)	Normal: Lower than 25kg/m^2	57.368	6	<0.001
	Over weight: 25-30 kg/m^2			
	Obese: Higher than 30 kg/m^2			
Waist circumference (cm)	Men: <94 cm and women: <80 cm	37.824	6	<0.001
	Men: 94-102 cm and women: 80-88 cm			
	Men: >102 cm and women: >88 cm			
Physical activity daily 30 min	Yes	52.478	3	<0.001
	No			
Vegetables, fruit or berry consumption	Every day		3	
	Not every day	13.861		0.003
History of hypertensive and/or anti-hypertensives	No		3	
	Yes			
History of high blood glucose	No	49.279	3	<0.001
	Yes			
Blood pressure	<140/90 mmHg	7.931	3	0.047
	>140/90 mmHg			
Gender	Male	59.446	3	<0.001
	Female			
Marital Status	Single	13.689	3	0.003
	Married			

BMI: Body mass index; FINDRISC: Finish Diabetes Risk Score; Pearson chi-square: λ value; df: degree of freedom; p<0.05 = significant

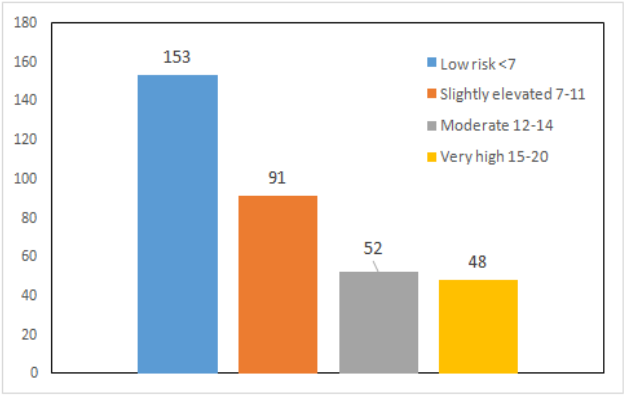

Fig 1. Risk assessment scoring system (FINDRISC) among Bangladeshi adult (N=323).

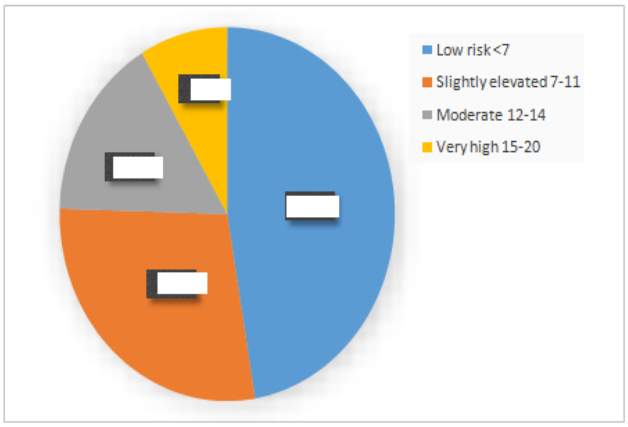

Fig 2. Percentage of total risk score (FINDRISC) among Bangladeshi adult (N=323).

VI. CONCLUSION

The FINDRISC questionnaire designed by Finnish diabetic association is clearly demonstrates that this scoring system can work reasonably well as screening tool, detecting undiagnosed T2DM in the general population. Findings in this study showed a positive association between the FINDRISC score and undiagnosed T2DM in the general population. It also estimates the probability of a person to develop diabetes within the next 10 years. People with high risk of DM should be referred for early intervention and changes to a healthy lifestyle and primary prevention to prevent or delay the onset of T2DM. The findings may help the health care professionals to substantiate the possible improvement in glucose metabolism and life style changes, and better convince people at high risk of T2D to take action towards healthier lifestyle habits.

VII. LIMITATIONS

This study is limited by the cross-sectional design and is not causal or effect study or measure of temporal changes. Some factors that can influence blood glucose levels (e.g. co- morbid conditions, genetically inherited haemo glob inopathies) have not been studied. Validation of the risk assessment with a large sample size in different populations would have enhanced the generalizability of the results.

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DECLARATION OF CONFLICTING INTERESTS

There are no organizations or communities with conflict of interest or coveting interests related to the study. The co-author declare that he has no competing interests.

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