

Case Report

Screening and Construction of Score Based Risk Factors Assessment Questionnaire for Earlier Detection of Type-2 Diabetes Mellitus among Tangail Population

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Keywords

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- Risk Factors
- Risk Assessment Questionnaire
- ROC curve

Abstract

Type 2 Diabetes [T2D] incidence rate is increasing alarmingly among Bangladeshi population. A very few data are available in Bangladesh for T2D disease. The main objectives of this study were to estimate significant risk factors of diabetes mellitus for the Tangail population and develop a valid and non-laboratory based questionnaire to assess risk of diabetic incidence.

Method: A structured questionnaire was administered to 4]] respondents from the Diabetic Care Center of Tangail district. The most significant risk factors were identified using Binomial logistic regression and area under the curve-receiver operating characteristics method [ROC]. The scoring of risk assessment questionnaire was performed and a cut-off score was also determined with suitable specificity/sensitivity ratios.

Results: T2D occurred most in the age of ≥ 45 [69.5%] which made age as the significant risk factor. Other major risk factors are family history or hereditary [p <] [1], irregular exercise [p =].[42], red meat intake [p <]1], gender [p =].]33], BMI [p =].]39], and waist circumference [p =].]37].

Conclusions: The final score based questionnaire could be a reliable tool for early assessment of type 2 diabetes among Tangail population.

INTRODUCTION

Diabetes is a metabolic disorder, which is a foremost health problem in the world [1]. There are two major forms of diabetes, type 1 [previously called insulin-dependent diabetes mellitus, IDDM or juvenile-onset diabetes, an autoimmune disease resulting in the destruction of insulin-producing cells] and type 2 [previously called noninsulin-dependent diabetes mellitus, NIDDM or maturity-onset diabetes] [2]. In type 2 diabetes [T2D], the pancreas is usually producing enough insulin, but for unknown reasons the body does not respond to the insulin effectively, a condition known as insulin resistance and after several years, insulin production decreases [3]. At present, the diabetic population number in Bangladesh is 8.4 million, which is expected to double by 2]]3], according to International Diabetes Federation [Islam and Rahman 2] [12]. Moreover, [9]- 95] % of the diabetic patients in Bangladesh have T2D. [4]. But only a few population based studies on T2D are undertaken in Bangladesh

which is not sufficient for proper management [5-9] and most of the studies done based on prevalence of T2D and assessment of different risk factors of T2D [1]-15]. To realize the risk of T2D many developed countries already have made an approach to identify risk factors of T2D for their population and from these to develop a score based questionnaire subsequently such as Australia [16], Canada [17], Finland [18], Libya [19], Qatar [2]], West Indies [21] etc. From the previous studies 16 risk factors were considered for T2D assessment in Tangail population which includes- age, gender, hereditary, previous health examination, use of anti-hypersensitive drugs, smoking, food habit, physical activity, body mass index [BMI], waist circumference, mental trauma, uptake of red meat, hypertension, heart disease [5-15]. Similar studies also done for other disease like asthma [22] and heart diseases [23, 24]. Therefore, the aim of our study was to identify whether the significant risk factors from these 16 extracted factors are associated with T2D in Tangail

population and from these to make a score based risk evaluation questionnaire from which it will be possible to predict the occurrence of T2D earlier.

RESEARCH DESIGN AND METHODS

Study design

First the population of Tangail was stratified according to diabetic or non-diabetic, gender and age. Then the principle of random sampling was used in each stratified area.

Study area and Population

This study was conducted in Tangail district of Dhaka Division in Bangladesh over a period from January to May of 2012. Tangail was selected as a study area because it contains both rural and urban dwellers. The population of Tangail is 3253961 with nearly half male and female [5]. 2% male [49.98% female] [5]. Data from 4]] people with and without type 2 diabetes were collected from Diabetes Hospital of Tangail who came for regular checkup in this hospital that covers the different Thana of this district by purposive sampling process. An ethical approval was obtained from the Research Ethics Committee of Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders [BIRDEM] hospital [Reference no: BIRDEM/Ethics/2]12/45] before distributing the questionnaires. After an oral glucose tolerance test [OGTT] which includes both a fasting plasma glucose [FPG] and a 2-hour glucose level following administration of 75 g of glucose, we selected 2]] people who were type 2 diabetic patients and 2]] people who were not diabetic patients. A diabetic patient was considered who had a fasting blood glucose level ≥ 7.0 mmol/L and 2-hour post-prandial reading of ≥ 11.1 mmol/L. Both men and women of 25-86 years ages were considered eligible as type 2 diabetic patients and for controls. After selection of type 2 diabetics and controls, the annual face-to-face survey was conducted in the hospital. The exclusion criteria was previously diagnosed diabetes, severe renal disease, disease with a strong impact on life expectancy, and therapy with drugs known to influence glucose tolerance [thiazide diuretics, artery-blockers, and steroids], patients with type 1 diabetes who were confirmed by their general practitioner or doctors of that hospital as having type 1 diabetes, gestational diabetes, and pregnant women.

Questionnaire design

Based on a literature review a well-organized questionnaire was developed and tested with a pilot survey. The same questionnaires were designed for both type 2 diabetic patients and those free of diabetes [control group]. Sixteen risk factors were selected from the literature review and data were collected based on these risk factors. After the pilot study, some necessary corrections and modifications were needed for the validity of the questions. The questionnaire was modified and 14 risk factors were selected for the final questionnaire. These 14 risk factors included age, gender, BMI [body mass index], hereditary, waist circumference, red meat intake, smoking, mental trauma, heart disease, systolic blood pressure, diastolic blood pressure, food habit [eating plentiful vegetables and fruits], physical activity [at least 3] minutes walking in morning and evening everyday including normal daily activity], and medication.

Physical measurements

Weight was measured in kilogram and height in meter to obtain BMI as the ratio of weight to the square of heights in kilogram/meter². Calculations of weight from participants were done by weight machine without shoes and any objects in the pocket. The heights were taken from toes of bare feet to head. According to the revised standards for adult obesity in Asia obese, overweight and healthy weight was classified [25]. Waist circumference was measured midway between the lowest rib and top of the iliac crest in meters by meter scale; where waist circumferences ≥ 1.0 meter for males and ≥ 0.8 meter for females were considered a risk factor for T2D [Chen et al. 2]11]]. Moreover, hypertension was also identified through WHO criteria as systolic blood pressure [SBP] ≥ 140 mmHg and diastolic blood pressure ≥ 90 mmHg or currently taking medication for high blood pressure. Zero mercury sphygmomanometer was used to measure SBP and DBP from left arm of participants while seated. Two reading were taken 5 minutes apart and the mean of the two was recorded as final blood pressure.

Behavioral risk measurements

A positive response for physical activity of participants was considered those who usually do walking or physical work daily at least 3] minutes or more. Daily, occasional smokers and non-smokers were classified according to currently smoking habit of non-diabetic participants and previous smoking record of diabetic patients as a risk factor of T2D.

Statistical analysis

Statistical Package for Social Sciences [SPSS, version 14, SPSS Inc. Chicago, Illinois, USA] software was used to analyze obtained data for defining significant risk factors. 'Risk relative ratio' with 95% confidence interval [CI] of all risk factors was generated in the cross tabulation model. The significant and non-significant risk factors were classified on the basis of p-value that is described in Table 1 and those with $p < 0.05$ values were considered for the development of the final questionnaire. Significant risk factors were determined from relative risk ratio using the χ^2 [chi square] test. Scores of significant risk factors were calculated on the basis of odds ratio [OR] with 95% CI in the binary logistic model. Age ranges were established to find the highest risk age category. The final questionnaire was compared with hereditary and age prediction of accuracy level of the questionnaire through Receiver Operating Characteristic [ROC] curves. A score ranges for risk of developing T2D were established on the basis of the most appropriate sensitivity-specificity ratio of different cut-off score points.

RESULTS

After pilot survey 14 risk factors were considered as variables for statistical analysis. Among these fourteen risk factors age and hereditary were more significant independent risk factors for diabetes. 69.5% of patients with diabetes were ≥ 45 years of age. Table 1 shows the frequency of significant and non-significant risk factors and significant risk factors are separated here on the basis of their p value. Moreover, Table 2 describes that the prevalence of T2D of > 64 years group were 3.22[RR] [95% CI, 1.56-6.63] times higher than individuals aged 55-64 years. In the same way,

patients of 55-64 years had prevalence of T2D 1.66[RR] [95% CI, 1.17-2.57] times more likely than 45-54 years-old. Furthermore, the hereditary of diabetes [RR 2.268, 95% CI 1.792- 2.889, $p < .001$] and uptake of red meat [$p < .001$], RR 1.826, 95% CI 1.225-2.929] were the most significant risk factors while BMI [$p = .039$, RR 1.258, 95% CI 1.11-1.583], physical activity [$p = .042$, RR 1.269, 95% CI 1.117-1.629] and waist circumference [measure of obesity] [$p = .037$, RR 1.26, 95% CI 1.113-1.63] were found as significant risk factors from their independent relative risk ratio.

Seven risk factors were eliminated because they were not significant including food habit, mental trauma, heart disease, medication, SBP and DBP. A history of smoking was omitted in this analysis because most females in our country are not habituated with smoking for their religion or social rituals and male patients could not quantify units of smoking accurately. The characteristics and significance levels of the all risk factors were displayed in Table 1.

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Table 1: The frequencies and significance levels of the all fourteen risk factors.

Variables	Total number of Respondents	% of total Respondents N=400]	Total number of Diabetes Patient	% of Diabetes Patient	% of Total with Diabetes Patient	P value <.05
Age						
>64 years	38	9.5	29	76.3	14.5	<.001
55-64 years	72	18	45	62.5	22.5	<.001
45-54 years	124	31	65	52.4	32.5	.01
35-44 years	121	30	44	36.7	22	.119
<35 years	46	12	17	37	8.5	.557
Gender						
Male	231	57.5	126	54.8	31.5	.133
Female	170	42.5	74	43.5	18.5	
BMI						
≥25 kg/m ²	247	61.8	134	67	33.5	.139
<25 kg/m ²	153	38.2	66	33	16.5	
Hereditary						
Yes	215	53.8	145	67.44	72.5	<.001
No	185	46.25	55	29.72	28.5	
Medication						
Yes	141	35	76	54.3	19	.124
No	260	65	127	63.5	31.8	
Waist circumference						
≥ 9]cm for Male	255	63.8	138	69	34.5	
And ≥ 8]cm for Female						.137
< 9] cm for Male	145	36.3	62	31	15.5	
And < 8] cm for Female						
Red meat						
Yes	342	85.5	183	53.5	91.5	.001
No	58	14.5	17	46.5	9.5	
Smoking						
Yes	167	41	73	36.5	18.3	.134
No	233	58	127	63.5	31.8	
Mental trauma						
Yes	144	36	81	41.5	21.3	.288
No	256	64	119	59.5	29.8	
Heart disease						
Yes	93	23.2	64	32	16	.117
No	307	76.8	136	68	34	
Systolic blood pressure						
≥14]mmHg	73	18.3	42	21	11.5	
<14]mmHg	327	81.8	158	79	39.5	.198

the final score points for the variables ranges and these score points were shown in Table 3. The total score points obtained in the scorecard was 23. However, the entire sample of 4] participants yielded an AUC of .836 for the seven risk factors [total risk associated questionnaire] in both ROC curves [Figure 1]. The total risk associated questionnaire [AUC .836] was significantly better than age [AUC .64] and hereditary [AUC .688]. Before choosing a minimum score, several cut-off scores were examined with respect to specificity and sensitivity Table 4. 97% sensitivity was found for score of ≥ 1] with acceptable specificity. However, a cut-off score of 18 was chosen with a high specificity [95%] to minimize additional testing and false positive results to maximum 5%. On the basis of percentage of diabetic patients, risk scores were divided into four categories [negligible, low, high and very high] [Table 5]. Age, gender, waist circumference, BMI, physical activity and red meat- risk factors were combined to form a modifiable risk factors score [9 modifiable Criteria in total]. The positive likelihood ratios [LR+] were $> 1.$] whereas; the negative likelihood ratios [LR-] were $< 1.$] for all score categories [Table 4].

DISCUSSION AND CONCLUSION

The World Health Organization [WHO] ranked 1] countries according to the highest diabetic patients where Bangladesh was in 1]th position for 2]]] and will be the 7th position for 2]3] [1]. The risk assessment tools for T2D diabetes has been developed for diagnosis of T2D at early stage on the basis of 7 risk factors [age, hereditary, physical activity, red meat, BMI, waist circumference and gender] were identified as significant risk factors [$p < .$]5] and these risks factors are easily self-assessed.

Among the risk factors, age, hereditary and uptake of red meat were the most significant followed by BMI. Smoking and alcohol were not significant. This may be attributed to the Tangail people's lifestyle. In the Tangail district the majority of people live in rural areas. BMI, waist circumference and smoking received higher scores in the final questionnaire of many countries like AUSDRISK [16], CANRISK [17], and TRAQ-D [21]. This may be since Asian people have smaller waist circumferences and BMI than in people of Europe origin [1]]. The people aged > 64 were at the highest risk to attain T2D; whereas, the lowest score was found for people of < 35 years. Moreover, the prevalence of T2D in the individuals aged 55- 64 were higher than aged 45-54 and

35-44. The results were consistent with other studies conducted in Bangladesh [1]-13]. The prevalence of diabetes increased with increasing age. Hereditary was the second most proximal risk factor in the Tangail area. Hereditary was a leading risk factor for 53.5% of T2D patients. Some studies also found strong relation between family history and T2D incidence [1], 14, and 15]. The percentage of male participants [54.8%] with T2D was higher than that of female participants [43.2%]. This data was supported by the IDF atlas which reported that 63% of the T2D patients were male [26]. In contrast, most of the studies conducted in Bangladesh found higher occurrence of the disease among female [8, 13, 14, and 27]. Therefore, gender and lifestyle of people play a significant role in T2D occurrence. Lifestyle variables consist of four risk factors- BMI, waist circumference, physical activity and red meat uptake. Approximately one-third [36%] of diabetic patients did not meet minimum physical activity requirements [3] minutes, twice per day], making low physical activity a significance risk factor. On the other hand, 39.5% of the total diabetic patients consumed red meat making it on par with low physical activity as a risk factor. To our knowledge it is the first study which included red meat intake history as variables. Moreover, 17.5% of the total diabetic patients were overweight: 17.8% had BMI > 25 and 17.8% of the total diabetic patient had waist circumference over 9]. This result was similar with the other studies of Bangladesh [17-24]. The score points from the four risk factors were considered as a modifiable risk factors. The mean numbers of modifiable risk factors among patients without and with diabetes < 65 years were 2.]3 and 6 respectively. Among diabetic patients, 95% had a modifiable risk factor score of > 3 . If they ceased eating red meat, reduced their weight and decreased their waist circumference and engaged in walking continuously for 3] minutes twice per day, overall 65% of all participants could have reduced their diabetic risk score by an average of 6.4 points.

A risk estimate can be made on the basis of a combination of risk factors, rather than using a single cut-off value. A positive likelihood ratio $> 1.$] for a diagnostic test is considered to be strong evidence to 'rule in' disease, whereas a negative likelihood ratio $< 1.$] is considered sufficient evidence to 'rule out' disease. From the Table 5, it was found that if any participant does score ≤ 8 , it can be considered as negligible score. This is because in this range, presentence diabetic patient was very low. Similarly, the range of score points- 9-11, 12-15, ≥ 16 were considered as low, high, very high risk respectively as prevalence of T2D.

Table 2: The value of relative risk ratio and chi square test of the seven selected risk factors are given below.

Risk factors	Chi Square	P value	Relative ratio[RR]	risk	95% CI
Age					
>64 years		$< .$]1	3.22		1.56-6.63
55-64 years	26.98	$< .$]1	1.66		1.]7-2.57
45-54 years		.]1	1.1]1		.]821-1.476
35-44 years		.]19	.]578		.]422-.]793
<35 years		.]557	.]586		.]321-1.]3
hereditary	55.]7]	$< .$]1	2.268		1.792- 2.889
Red meat	1].667	.]1	1.826		1.225-2.929
BMI	4.234	.]39	1.258		1.]1]-1.583
Physical activity	4.114	.]42	1.269		1.]7]-1.629
Waist circumference	4.327	.]37	1.266		1.]13-1.6]3
gender	4.512	.]33	1.259		1.]17-1.569

Table 3: Results from the logistic regression analyses for predicting T2D and scores assigned to each variable.

Variables	Odd ratio	95% Confidence Interval	Score
Age			
≥65 years	6.73	2.16-19.143	7
55-64 years	5.166	2.415 - 14.732	5
45-54 years	2.923	1.27 - 6.717	3
35-44 years	1.334	.614 - 2.897	1
<35 years	1]
Gender			
Male	1.7	.721-2.868	2
Female	1]
BMI			
≥25kg/m ²	1.8	.533- 2.89	2
<25 kg/m ²	1]
Hereditary			
Yes	4.8	2.591-8.264	5
No	1]
Physical Activity			
No	1.95]	.839-2.]66	2
Yes	1]
Waist circumference			
≥9] cm [male] and ≥8]cm [female]	1.76	1.]48-2.596	2
<9]cm[male] and<8] cm[female]	1]
Red meat			
Yes	2.78	1.388-5.787	3
No	1]
Total			23

Table 4: Sensitivity, specificity, positive and negative predictive values and likelihood ratios for the selected risk point levels.

Criterion	Sensitivity [%]	Specificity [%]	PPV [%]	NPV [%]	LR[+]	LR[-]
≥1]	97	28	57	9]	1.34	.1]
≥11	91	35	58	79	1.4]	.26
≥12	81	49	61	72	1.58	.39
≥13	72.5	58	63	68	1.71	.47
≥14	59	71	67	63	2.]3	.57
≥15	52	77	7]	62	2.26	.62
≥16	45	85	76	6]	3.]]	.64
≥17	31	91	78	57	3.4]	.75
≥18	25	95	83	56	5.]]	.78

Table 5: Score ranges with corresponding risk rating.

Score range	% with diabetes	Risk rating
]-8	3	negligible
9-12	34	Low
13-16	73	High
≥ 17	9]	very high

In the conclusion, a simple and easily self-administered scorecard can be developed using statistically significant risk factors. This could be a screening tool for the population of Tangail for the early detection of T2D. The final questionnaire prepared from this study was an approach to predict T2D among Tangail population. This score-based T2D risk assessment tool may play a role in assessing current risk of occurring T2D and prevalence

of T2D for next 5 or 1] years of Tangail people. Moreover, this tool can be used in public health campaigns and public health care centers of Tangail.

Limitation and Further Study

The limitations of the study were the small sample size and that ethnicity is not included as a risk factor. Another limitation could be that smoking, hypertension and food habits were not found as significant risk factors because most of the participants in this study were from rural areas where there are healthier lifestyles than in urban areas. Future studies should be conducted with a representative sample of Bangladesh people including urban, rural and tribal people of different areas of Bangladesh. These studies should consider additional relevant demographic and clinical measures.

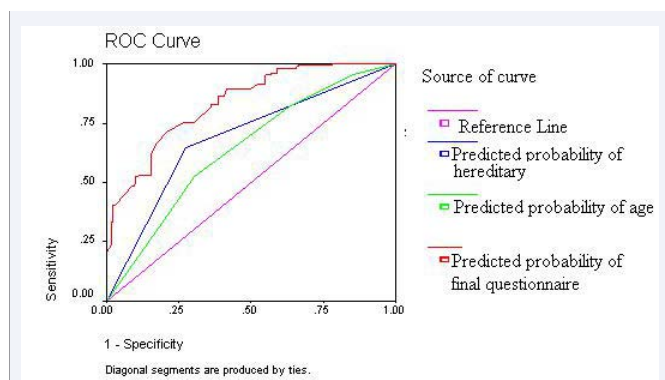


Figure 1 Significance level of Total Risk Associated Questionnaire against only age or hereditary for the entire sample.

ETHICAL CONSIDERATION

During collection of data written consent was taken from literate volunteers both in English and native language and verbal consent was taken from those who are ill.

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AUTHORS' CONTRIBUTIONS

AM UF conceived the research idea and perform the data collection. UF, MM and PJ actively involved in the data collection and PJ, UF perform the statistical analysis and results preparation. AAE and AHT helped in designing the study and supervision of the work. and PJ prepared the manuscript. AHT and AAE contributed intellectual thought, final revision and editing of the manuscript. All authors have read and approved the submitted version of manuscript.

REFERENCES

- Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diab Care*. 24; 27:147-153 doi: 1.2337/diacare.27.5.147.
- Vinay K, Nelson F, Abul AK, Ramzi CS, Stanley RL. Robbins and Cotran Pathologic Basis of Disease [7th ed.. Philadelphia, Pa.: Saunders. 25; pp 1194-1195.
- Kraegen EW, Cooney GJ, Turner N. Muscle insulin resistance: a case of fat overconsumption, not mitochondrial dysfunction. *Proc. Natl. Acad. Sci. USA* 15:7627-7628.
- Islam R, Rahman O. The Risk Factors of Type 2 Diabetic Patients Attending Rajshahi Diabetes Association, Rajshahi, Bangladesh and Its Primary Prevention. *Food and Public Health*. 2:12; 2: 5-11. doi: 1.5923/j.fph.21222.2.
- Rahman O, Islam MR. Association between Fasting of Ramadan and Risk Factors of Diabetes. A Study from Rajshahi City in Bangladesh. *Advance Journal of Food Science and Technology*. 3:36-365.
- Begum FAMA, Azad AK, Alim MA, Ekram ARMS. Nutritional Status of Diabetic Patients Attending to a District Level Diabetic Center. *Journal of Teachers Association*. 4;17: 89-92.
- Akhter A, Fatema K, Afroz A, Bhowmik B, Ali L, Hussain A. Prevalence of Diabetes Mellitus and its Associated Risk Indicators in a Rural Bangladeshi Population. *The Open Diabetes Journal*. 2: 11; 4:6-13.
- Hussain A, Vaaler S, Sayeed MA, Mahtab H, Ali SMK, Khan AKA. Type 2 diabetes and impaired fasting blood glucose in rural Bangladesh: a population based study. *European Journal of Public Health*. 26; 17[3:291-296.
- Rahman MM, Rahim MA and Nahar Q. Prevalence and risk factors of Type 2
- Diabetes in an urbanizing rural community of Bangladesh. *Bangladesh Med Res Counc Bull*. 27; 33:48-54.
- Sayeed MA, Mahtab H, Khanam PA, Latif ZA, Ali SK, Banu A, Ahren B, Khan AA. Diabetes and impaired fasting glycemia in a rural population of Bangladesh. *Diabetes care*. 23 Apr 1;26[4:134-9
- Sayeed MA, Mahtab H, Khanam PA, Ahsan KA, Banu A, Rashid AB, Khan AA. Diabetes and impaired fasting glycemia in the tribes of Khagrachari hill tracts of Bangladesh. *Diabetes care*. 24 May 1;27[5:154-9.
- Rahim MA, Hussain A, Azad Khan AK, Sayeed MA, Keramat Ali SM, Vaaler S. Rising prevalence of type 2 diabetes in rural Bangladesh: a population based study. *Diabetes research and clinical practice*. 27;77[2:3-5.
- Rahim MA, Rahman ML, Mostafa AW, Ahmed SF. The Prevalence Rate of Diabetes Mellitus [DM in Rural Population of Bangladesh. 211;4, [2:41-8.
- Ahasan HAMN, Islam MDZ, Alam MDB, Miah MDT, Nur Z, Mohammed FR, et al. Prevalence and Risk Factors of Type 2 Diabetes Mellitus Among Secretariat Employees of Bangladesh. *Journal of Medicine*. 211;12[2:125-3.
- Chowdhury MA, Uddin MJ, Khan HM, Haque MR. Type 2 diabetes and its correlates among adults in Bangladesh: a population based study. *BMC Public Health*. 215 Dec;15[1:17.
- Chen L, Magliano DJ, Balkau B, Colagiuri S, Zimmet PZ, Tonkin AM, Mitchell P, Phillips PJ and Shaw JE. AUSDRISK: an Australian Type 2 Diabetes Risk Assessment Tool based on demographic, lifestyle and simple anthropometric measures. *Med J Aus*. 21; 192:197-22.
- Kaczorowski J, Robinson C, Nirenberg K. Development of the CAN RISK questionnaire to screen for pre-diabetes and undiagnosed type 2 diabetes. *Canadian Journal of Diabetes*. 29; 33[4:381-385.
- Schwarz P EH, Jiang Li, Reimann M, Schutte AE, Bergmann A, Hanefeld M, Bornstein SR, Schulze J, Tuomilehto J, and Lindstrom J. The Finnish Diabetes Risk Score Is Associated with Insulin Resistance and Progression towards Type 2 Diabetes. *Clin Endocrinol Metab*. 29; 94[3:92-926.
- Abduelkarem AR, Sharif SI, Hammrouni AM, Aldouibi SS, Albraiki WM, El-Shareif HJ. Risk calculation of developing type 2 diabetes in Libyan adults. *Practical Diabetes Int*. 29; 26[4:148-151.
- Bener A, Zirie M, Janahi IM, Al-Hamaq AOOA, Musallam M, Wareham NJ. Prevalence of diagnosed and undiagnosed diabetes mellitus and its risk factors in a population-based study of Qatar. *Diabetes Research and Clinical Practice*. 29; 84:99-
- Latcha Z, Seereeram R, Kamaloden A, Sanchez S, Deonarine U, Sinanan R, Mungrue K. TRAQ-D [Trinidad Risk Assessment Questionnaire for Type 2 Diabetes Mellitus: a cheap, reliable, non-invasive screening tool for diabetes. *British Journal of Diabetes & Vascular Disease*. 21; 1 [4:187-192.
- Forno E, Fuhlbrigge A, Soto-Quirós ME, et al. Risk factors and predictive clinical scores for asthma exacerbations in childhood. *Chest*. 21;138[5:1156-65.

24. Mainous AG, Koopman RJ, Diaz VA, Everett CJ, Wilson PW, Tilley BC. A coronary heart disease risk score based on patient-reported information. *Am J Cardiol.* 27;99[9]:1236-41.
25. Stephanie E. Chiuve, Nancy R. Cook, Christina M. Shay, Kathryn M. Rexrode, Christine M. Albert, JoAnn E. Manson, Walter C. Willett, Eric B. Rimm. Lifestyle-Based Prediction Model for the Prevention of CVD: The Healthy Heart Score. *J Am Heart Assoc.* 214;3:e954.
26. Low S, Chin MC, Ma S, Heng D, Deurenberg-Yap M. Rationale for redefining obesity in Asians. *Ann. Acad. Med. Singapore.* 29; 38:66-69.
27. IDF Diabetes Atlas Eighth Edition, <https://www.idf.org/e-library/epidemiology-research/diabetes-atlas/134-idf-diabetes-atlas-8th-edition.html>; 217 [accessed 18 February 218].
28. Hussain A, Rahim MA, Azad Khan AK, Ali SMK, Vaaler S. Type 2 diabetes in rural and urban population: diverse prevalence and associated risk factors in Bangladesh. *Diabetic Medicine.* 25;22[7]:931-6. UF,

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