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A Cross Sectional Study to Ascertain the Ability of the FINDRISC Diabetes Risk Assessment Tool to Detect Pre-Diabetes

Satvinderjit Singh Hullon*, Muhammad Fariz Zaqwan, Yi Bohrt Lau, Manpreet Kaur, Foung Zoung Loi, Hui Yen Wong

Faculty of Medicine, Melaka Manipal Medical College (Manipal Academy of Higher Education (MAHE)), Melaka, Malaysia

Email address

satvinhullon@yahoo.com (S. S Hullon), along_zak@yahoo.com (M. F. Zaqwan), yiborhtlau@gmail.com (Yi B. Lau), mspreet@yahoo.com (M. Kaur), fzon94@gmail.com (F. Z. Loi), huiyen_0309@hotmail.com (H. Y. Wong)

*Corresponding author

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Abstract

Prediabetes is characterized by blood glucose levels that are higher than normal but not high enough to be classed as diabetes, and known to be a high risk state. According to the Ministry of Health, pre-diabetic people are 2-3 times more likely to develop diabetes, which is known to be one of the top 10 deadliest diseases in Malaysia. A new screening tool to screen for diabetes was developed in the form of a questionnaire which provided a cheaper and convenient tool as compared to using laboratory based diagnostic tests, that is the Finnish Diabetes Risk Score (FINDRISC). It is the most valid tool preferred for resource-limited settings by International Diabetes Federation (IDF). However, it was derived and validated for the specific Caucasian population and not the Malaysian population. A cross sectional study was performed among medical undergraduates of Melaka Manipal Medical College (MMMC), Malaysia, with a sample size of 180 participants selected by simple random sampling. Any healthy participant between the age of 18-30, not diagnosed with diabetes mellitus, and students from MMMC were included however those that did not give informed consent, did not complete the questionnaire, and participants that fasted prior to the study were excluded. Data was collected by self-administered questionnaires, filled prior to finger prick for blood glucose. Following multivariate analysis, a positive association between the FINDRISC Score and Waist Circumference, BMI, Physical Activity of less than 30 minutes, first degree relatives with diabetes and previous high glucose. An association was also found between the FINDRISC Score and Waist circumference as well as blood glucose. The sensitivity was 46.67% and specificity 64.55%, with Positive Predictive Value 59.35% and Negative predictive value 74.74%, hence the use of the FINDRISC Diabetes Risk Assessment Score is a moderate to poor screening tool for pre-diabetics, this is attributable to its' poor sensitivity and high specificity, and a negative predictive value higher than positive predictive value.

Keywords

FINDRISC, Diabetes, Pre-diabetes, Malaysia

1. Introduction

Prediabetes is characterized by the presence of blood glucose levels that are higher than normal but not high enough to be classed as diabetes, it is known to be a high risk state. [1] However, Diabetes Mellitus is defined as a variable disorder of carbohydrate metabolism [2]. According to the Ministry of Health, pre-diabetic people are 2-3 times more likely to develop diabetes. [3] Diabetes is known to be one of the top 10 deadliest diseases in this country, [4] with an increasing prevalence of Type II Diabetes Mellitus among adults aged more than 30 years in Malaysia. In 2011, the fourth Malaysian National Health and Morbidity Survey (NHMS IV) reported that the prevalence of Type II Diabetes increased to 20.8%. According to a study carried out in 2012,

5-10% of people per year with pre diabetes will progress to diabetes and the same proportion also return back to normoglycemia.

This rising trend is due to many factors such as population growth, aging, urbanization, increasing prevalence of obesity (especially adolescent obesity) and physical inactivity. [5, 6] A family history of diabetes is a known risk factor for diabetes and a criterion for screening in most current guidelines. [7, 8] Fasting plasma glucose (FPG) has been a commonly used tool in screening diabetes, but it has a large random variation, only reflects current glycemic status, and requires people to fast for at least 8 hours before the test. Oral glucose tolerance test (OGTT) has been shown to be the most valid tool for diagnosing diabetes. [9] However, OGTT is more expensive [10], inconvenient, and has weak reproducibility, making it unacceptable for most patients and providers as the first line of screening tool. [11]

Due to the shortcomings foreseen before the study, Random Blood Glucose sampling was employed. As per a study, the Random Blood Glucose was better in the 1-hour period after eating with a sensitivity of 82% and specificity of 78% for those 30-year-old participants of the study [12, 13], however another study concluded that sensitivity was 73% and specificity was 95% compared to random urine glucose which had a sensitivity of 23% and specificity of 99%. [14]

A new screening tool to screen for diabetes was developed in the form of a questionnaire which provided a cheaper and convenient tool as compared to mass screening using laboratory based diagnostic tests, which are usually not cost-effective. An example of this is the Finnish Diabetes Risk Score (FINDRISC) which is the most valid and inexpensive tool preferred for resource-limited settings by International Diabetes Federation (IDF). [15] It measures the usual clinical characteristics, such as age, body mass index (BMI), waist circumference (WC), physical activity, dietary consumption of fruits, vegetables, use of antihypertensive medication, history of high blood glucose, and family history of diabetes. [16] However, this risk score was derived and validated for the specific Caucasian population which may bring discriminatory results for the Malaysian population.

2. Methods

A cross sectional study was performed among medical undergraduates in Malaysia, from both Muar and Melaka campuses of Melaka Manipal Medical College (MMMC), from August 28th, 2017 to September 8th, 2017. Melaka Manipal Medical College was launched in 1997 as a constituent of Manipal University, Manipal, India. It was the brainchild of Dato' Dr. K. Pathmanaban and Dr. Ramdass Pai (Vice Chancellor of Manipal University), an agreement was hence signed in Delhi, 1993, by both Prime-ministers at the time, resulting in the first Indo-Malaysian collaboration, becoming a pinnacle of medical education in the country. MMMC offers a unique twinning program with the first Phase of 2.5 years in Manipal, India and the second Phase of 2.5 years in Muar and Melaka, Malaysia.

The estimated the sample size was to be 150 participants, with a prevalence of 10.9% [14] along with the infinity formula and confidence level of 95%, and an extra 20% for null responses coming to a grand total of 180. The 180 apparently healthy participants were selected by simple random sampling and inclusion and exclusion criteria as follows: any apparently healthy participant between the age of 18-30, not diagnosed with diabetes mellitus, students from MMMC and participants without prior impaired blood glucose were included. Participants that were excluded from the study included those that did not give informed consent, those that did not complete the questionnaire, as well as participants that had fasted prior to the study sample obtainment.

Data was collected by self-administered questionnaires, which were filled prior to the finger pricking for blood glucose. The questionnaires were approved by the Institutional Ethics Committee of Melaka Manipal Medical College, Malaysia as well as the Head of the Department of Community Medicine, MMMC. All blood samples were only collected after signing the informed consent sheet. Data collected included those for age, weight, waist circumference, family history of diabetes mellitus and dietary and activity habits, as per the FINDRISC Diabetes risk assessment tool [15, 16]. The study population included 180 apparently healthy participants between the ages of 18-25 years, wherein a random blood glucose sample was obtained by pricking the finger of the non-dominant hand and placed on a OneTouch Glucometer (according to a research study, laboratory values and the percentage deviation from laboratory values was 0.2-10.5%) [17].

The Finnish Diabetes Risk Score (FINDRISC) is a risk stratification tool developed by Finnish authors Lindström and Tuomilehto and was first published in 2003 [18, 19]. In a cohort study in 1987 and 1992, Lindström et al found that the scoring tool had a sensitivity of 0.78 and 0.81, specificity of 0.77 and 0.76, and positive predictive value of 0.13 and 0.05 [19] respectively. In this cohort study they followed a random sample population aged between 35-64 years for 10 years, obtaining data of incident cases from the National Drug Registry. Using multivariate logistic regression models, they managed to assign each category a score. The positive predictive value was then ascertained in a population survey in 1992 with a follow up for 5 years [19, 20]. The maximum score that can be obtained is 26, however a score of greater or equal to 15 indicates a high probability of developing Diabetes in the next 10 years. The FINDRISC Scoring tests the following variables: age; body mass index (BMI); waist circumference; physical activity; dietary consumption of fruits, vegetables and berries; use of anti-hypertensive medications; history of high blood glucose; and family history of diabetes [21], the appropriate points allocated are depicted in Table 1 [21]. The age was taken in intervals between 18-44 years, 45-54 years, 55-64 years and more than 65 years, however the study population falls between the range 18-44 years, this was still significant ($p = 0.002$), as per a study carried out in Jordan [22]. The impact of BMI on diabetes duration decreases with

age [23], with the risk of developing Type II Diabetes Mellitus increased beginning with BMI's of 18.5-23.0 by 2.47 fold [24]. A study carried out in Australia concluded that increased time spent in sedentary behaviors, are independently associated with the risk of developing metabolic syndrome [25, 26]. Another study concluded that impaired insulin secretion is the first and main genetic factor predisposing to Type II Diabetes [27].

Table 1. *FINDRISC Diabetes Risk Assessment Questionnaire.*

Variable	Points given
Age	
Under 45 years	0 points
45-54 years	2 points
55-64 years	3 points
Over 64 years	4 points
Body Mass Index	
Less than 25kg/m^2	0 points
25-30kg/m^2	1 point
More than 30kg/m^2	3 points
Waist Circumference	
-Male	
Less than 94cm	0 points
94-102 cm	3 points
More than 102cm	8 points
-Female	
Less than 80cm	0 points
80-88cm	3 points
More than 88cm	8 points
More than 30 Minutes of Activity	
Yes	0 points
No	2 points
Daily consumption of fruits and vegetables	
Everyday	0 points
Not Everyday	1 point
Medications for High Blood Pressure consumed	
No	0 points
Yes	2 points
Previous reading of high blood glucose	
No	0 points
Yes	5 points
Any other family diagnosed with diabetes mellitus?	
No	0 points
Yes; grandparent, aunt, uncle, or first cousin	3 points
Yes; parent, sibling or child	5 points

Table 2. *Demographic characteristics, risk factors in FINDRISC score, blood glucose status, and FINDRISC risk score of study participants by gender.*

	MALE (N=70)		FEMALE (N=85)		TOTAL (N=155)	
Characteristic	**N**	**%**	**N**	**%**	**N**	**%**
Ethnicity						
Malay	22	31.4	22	25.9	44	28.4
Chinese	28	40.0	21	24.7	49	31.6
Indian	20	28.6	42	49.4	62	40.0
Allowance						
High	9	12.9	8	9.4	17	11.0
Moderate	42	60.0	54	63.5	96	61.9
Low	19	27.1	23	27.1	42	27.1
Parents Education						
High	25	35.7	37	43.5	62	40.0
Moderate	19	27.1	23	27.1	42	27.1
Low	26	37.2	25	29.4	51	32.9
BMI Status[a]						
Underweight	4	5.7	10	11.8	14	9.0
Normal	37	52.9	65	76.5	102	65.8
Overweight	27	38.6	7	8.2	34	21.9
Obese	2	2.8	3	3.5	5	3.3
Physically Active >30mins						
Yes	43	61.4	44	51.8	87	56.1
No	27	38.6	41	48.2	68	43.9
1st Degree Relatives with DM						
Yes	34	48.6	53	62.4	87	56.1
No	36	51.4	32	37.6	68	43.9
Random Blood Glucose Status [b]						
Normal	48	68.6	62	72.9	110	71.0
Pre-diabetic	22	31.4	23	27.1	45	29.0
FINDRISC Risk Score [c]						
Low	51	72.9	39	45.9	90	58.1
Slightly Elevated	17	24.3	41	48.2	58	37.4
Moderate	1	1.4	4	4.7	5	3.2
High	1	1.4	1	1.2	2	1.3

BMI, body mass index; DM, diabetes mellitus.

[a] BMI of <18.5kg/m^2 is considered as underweight, BMI of 18.5-25.0 kg/m^2 is considered as normal, BMI of 25.0-30.0 kg/m^2 is considered as overweight and BMI of >30.0 kg/m^2 is considered as obese.

[b] Random blood glucose of <6.7mmol/L is considered as normal and random blood glucose of >6.7mmol/L is considered as pre-diabetic.

[c] FINDRISC risk score of less than 7 is considered as low, 7 to 12 is considered as slight elevated, 12 to 15 is considered as moderate and more than 15 is considered as high

Table 3. *Demographic characteristics, risk factors in FINDRISC score, and FINDRISC score of study participants by gender.*

Characteristic	Male (N=70)	Female (N=85)	Total (N=155)
	Mean (SD)	Mean (SD)	Mean (SD)
Height (cm)	173.6 (6.5)	159.6 (6.5)	165.9 (9.6)
Weight (kg)	73.4 (12.4)	55.6 (9.1)	63.6 (13.9)
BMI (kg/m^2)	24.3 (3.6)	21.8 (3.4)	22.9 (3.7)
Waist Circumference (cm)	85.9 (8.7)	79.3 (8.8)	88.3 (9.3)
FINDRISC Score	5.4 (3.0)	6.8 (3.3)	6.2 (3.2)

BMI, body mass index.

3. Results

Demographic characteristics, risk factors in FINDRISC score, blood glucose status, and FINDRISC risk score of study participants by gender are shown in Table 2 and 3. The 155 students that voluntarily participated in this cross-sectional study, were classified according to ethnicity to determine the association between ethnicity and blood glucose levels. Approximately 40% Indian, 31.6% Chinese, and 28.4% Malay participants were obtained, as shown in Table 4. Table 5 demonstrates that there is a slight difference between the FINDRISC Score and Blood Glucose level when compared to race.

Table 4. *Number of study participants by ethnicity.*

Ethnicity	Frequency	Percent	Cum. percent	Exact 95%LCL	Exact 95% UCL
CHINESE	49	31.61%	31.61%	24.39%	39.56%
INDIAN	62	40.00%	71.61%	32.22%	48.17%
MALAY	44	28.39%	100.00%	21.44%	36.18%
Total	155	100.00%	100.00%		

Following the multivariate analysis (Table 6), it was found that there was a positive association between the FINDRISC Score and Waist Circumference (P=0.0001). Another association was found between FINDRISC Score and BMI (P=0.0168). Physical Activity of less than 30 minutes was also found to be associated to the FINDRISC Score (P=0.00001). Another association was found between diabetes between first degree relatives and FINDRISC Score (P= 0.00001) as well previous high glucose and the FINDRISC Score (P= 0.00001).

Another association found was between that of waist circumference and blood glucose levels (P=0.0153) as shown in Table 7. However, no significant association between physical activity and fruit and vegetable consumption and the FINDRISC Score was found.

The main aim of the study was to determine the effectiveness of FINDRISC Diabetes Risk Score to detect pre-diabetics in the sample, it was found that the sensitivity of this test was 46.67%, specificity was 64.55%. The Positive Predictive Value of the test was found to be 59.35% and Negative predictive value was 74.74%.

Another aspect of the study was to determine the emotional impact on diabetes. Upon multivariate analysis, using Optimistic Bias (mistaken belief that one's chances of experiencing a negative event are lower), it was found that those who were more worried and those who perceived personal control, had lower blood glucose levels than those who were more optimistically biased (p= 0.00001).

Table 5. *FINDRISC score and blood glucose status by ethnicity.*

Ethnicity	FINDRISC		Blood Glucose Status	
	LOW/MODERATE	HIGH/SLIGTLY ELEVATED	Normal	Pre diabetes
CHINESE	34 (69.39%)	15 (30.61%)	31 (63.27%)	18 (36.73%)
INDIAN	33 (53.22%)	29 (46.78%)	42 (67.74%)	20 (32.26%)
MALAY	28 (63.64%)	16 (36.36%)	37 (84.09%)	7 (15.91%)
TOTAL	95 (61.29%)	60 (38.71%)	110 (70.97%)	45 (29.03%)

Table 6. *Multivariate analysis with FRINDRISC score.*

Variable	FINDRISC 95% coefficient incident	P value
BMI	0.031	0.0168
WAIST CIRCUMFERENCE	0.073	<0.0001
PHYSICALY ACTIVE>30MIN (YES/NO)	-3.19	<0.0001
VEGETABLE CONSUMPTION (NOT EVERYDAY/EVERYDAY)	-0.003	0.051
FIRST DEGREE WITH DM (YES/NO)	3.240	<0.0001
PREVIOUS HIGH GLUCOSE (YES/NO)	3.365	<0.0001

Table 7. *Association of waist circumference with blood glucose status.*

Variable	BGStatus 95% coefficient incident	P value
WAIST CIRCUMFERENCE	0.10	0.0068

4. Discussion

Advancing age is related to higher risk of developing diabetes mellitus in those that are susceptible. However, no prior study has been done to assess the status of pre-diabetes in a young adult population. To this point the various risk factors related to diabetes along with its prevalence data and trends in the country has been explained. Statistical analysis as of September 2017 is provided. As per the studies conducted prior [27], the association between BMI and blood glucose could be affected by weight loss, the mean weight of the participants was 63.63kg, this is very low as compared to those which show significant association to diabetes mellitus, as demonstrated by the results otherwise.

A study done found that waist circumference ≥94 cm in middle-aged men, identified those with increased risk for Type II Diabetes [7, 28], however according to the another study, adolescents above 16 years [29] and young adults should adhere to the International Diabetes Federation (IDF) Criteria [30], a waist circumference of >90cm in males and >80cm in females are at risk of being diabetic, however no study has been done to assess the status of waist circumference with pre-diabetes. It was found that a waist circumference of more than 79.3cm for females and more than 85.9cm for males were significantly associated with the FINDRISC Scoring Tool, thus elevating their risks for developing diabetes mellitus in the next 10 years.

The development of diabetes mellitus is not only hereditary but is also dependent on environmental interaction. BMI and weight gain are major risk factors for developing diabetes [31]. Obesity is not the sole result of low levels of physical activity but also arises from an energy imbalance that is there is no net energy loss, and it gets retained as fat. This fat contributes to the insulin resistance, and when paired with B-Cell dysfunction results in a failure to control the glucose levels [32]. This is suggestive as to the significant result found between Physical Activity and the risk of developing diabetes in the next 10 years. It has also been proven that physical activity can help prevent diabetes mellitus [31]. It was found that the physical activity is protective against developing diabetes and pre-diabetes.

As stated before, diabetes is related to genetics [31, 32], the association found between that of first degree family history and risk of developing diabetes mellitus in the next ten years is explained. Another study carried out also claims the family history to be an important determinant for developing diabetes [34], and hence pre-diabetes. On the other hand, no other studies have been done to determine the association between previous high blood glucose levels and risk of developing diabetes, this comes with the realization that the pervious high blood glucose readings might be due to overt diabetes (impaired fasting glucose) or due to wrong fasting procedures prior to testing for blood glucose levels.

The emotional qualities among participants were divided into three categories, that is, Worry (anxiety or unease towards a condition), Perceived Personal Control (belief that the individual is capable of influencing and making a difference in the events that surround their lives) and Optimistic Bias. According to the results those who were more worried or had perceived control had lower blood glucose scores than those with optimistic bias as their unique emotion. A review found that interventions for metabolic control included those for stress management, self-management, medications for depression and cognitive behavioral therapy

5. Conclusion

The use of the FINDRISC Diabetes Risk Assessment Score is a moderate to poor screening tool for pre-diabetes, this is attributable to its' poor sensitivity and high specificity, and a negative predictive value higher than positive predictive value. This means that more people would be negatively diagnosed as pre-diabetic in the population and would give a wrong 10-year chance of developing diabetes mellitus.

Finding effective means to prevent Type II Diabetes Mellitus is a critical public health priority which should be addressed. In the today's world, apart from life style modifications, development of tools to identify high risk individuals might benefit those who are at risk as they will be aware of what lies ahead. Furthermore, it is a feasible, non-invasive tool for screening and can be used in the population as well as in clinical practice to detect undiagnosed Type II Diabetes Mellitus. The study that was conducted to ascertain the ability of the FINDRISC Diabetes Risk Assessment tool to detect pre-diabetes showed positive association between the FINDRISC Score and waist circumference (p=0.0001), FINDRISC Score and BMI (p=0.0168), waist circumference and blood glucose level (p=0.0153), vegetable consumption Moreover, we found that those who were more worried and who perceived personal control, had lower blood glucose level than those who were more optimistically biased (p=0.00001). Through this study, the high predictive performance of FINDRISC is validated.

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