Developing a Diabetes Risk Score for Eastern Cape Province, South Africa

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Abstract

Background. It is estimated that 3.5 million South African live with type 2 diabetes and another 5 million may be undiagnosed. These undiagnosed diabetics are at very high risk of serious and life threatening chronic complications resulting from unmanaged condition. The outcome is high diabetes-related morbidity and mortality in South Africa with 58 deaths per day. The ***purpose*** of this study was to develop a Diabetes Risk Score (DRS) for the Eastern Cape Province of South Africa, that is a simple diabetes risk calculator for use in primary health care, and also by individuals themselves in identifying diabetes status. This is being done in India without the costly laboratory tests or other unaffordable clinical measures requiring specialized skills. ***Design and Methods.*** A total of 451 subjects attending Community Health Centers in the King Sabata Dalindyebo Municipality and Buffalo City Metropolitan Municipality Districts of Eastern Cape Province of South Africa, signed informed consent and participated in the study. Data collected included demographics, family history of diabetes, information about exercise practices and measurement of waist circumference. A diabetes risk score for each participant was generated for the following risks: age, family history of diabetes, exercise and waist circumference. The objective was to determine a composite diabetes risk score using the Receiver Operating Characteristic (ROC) curves and measuring the area under the curve for the optimal Diabetes Risk Score that predicts pre-diabetes/undiagnosed diabetes. ***Results.*** We have developed a Diabetes Risk Score for Eastern Cape based on the limited sample that was studied. ***Conclusion.*** The Diabetes Risk Score is 60.

Keywords: Diabetes Risk Score, Youden index, waist circumference, area under the curve, specificity, sensitivity, HOMA-IR, insulin resistance, pre-diabetes, South Africa, Eastern Cape Province,

Introduction.

In South Africa, about 6% of South Africans (3.5 million) suffer from Diabetes, and there are many more who are undiagnosed diabetics. The estimate is that another 5 million have pre-diabetes/undiagnosed diabetes) (Health 24, 2017 (1) and Mbanya, et al. 2010) (2). These undiagnosed diabetics are at very high risk of chronic complications resulting from the unmanaged condition. The diabetes-induced complications include frequent high blood pressure, retinopathy, macular oedema, coronary heart disease, cardiomyopathy and stroke (Mbanya, et al. 2010) (2). The outcome is high diabetes-related morbidity and mortality in South Africa (Mbanya, et al, 2010) (2). It has been reported that type 2 diabetes accounts for 58 deaths per day, making it the 5th highest cause of death (Pillay, et al 2016) (3). These data highlight the need to develop a simple, low-cost tool to aid in the classification and diagnosis of diabetes (Forst, et al. 2004) (4). A potential tool is a diabetes risk score (DRS) which has been shown to be a simple and cost-effective community-based method of screening for undiagnosed diabetes (Mohan, et al. 2005) (5), for predicting occurrence of diabetes, discriminating primary and secondary causes of diabetes (Mohan, et al. 2008) (6), and identifying risk for cardiomyopathy in normoglycemic individuals (Mohan, et al. 2007) (7). It has been demonstrated that the use of a DRS in a health center, helps in classifying diabetes and decreasing costs related to the type of diabetes (Sharma, et al, 2011) (8). In this study, a Diabetes Risk Score (DRS) was developed for use in the Eastern Cape Province of South Africa, as a simple diabetes risk calculator for use iprimarily in health care and also by individuals themselves. The DRS is easy to assess without the costly laboratory tests or other unaffordable clinical measures requiring advanced skills (Tables 2 and 3).

Design and Methods.

The design, methodology, and data obtained from patients attending Community Health Centers in the King Sabata Dalindyebo Municipality and Buffalo City Metropolitan Municipality Districts of Eastern Cape Province of South Africa, are described elsewhere (Gwebu ET, et al. 2017) (9).

Risk factors that were used in the development of the diabetes risk score:

1. *Age* scores were divided into three groups and coded as follows: <35 years scored as 0, 35- 49 years = 10, and ≥50 years = 20.
2. *Abdominal obesity*: Males – individuals with waist circumference < 90 cm scored as 0; ≥ 91 – 99 cm as 10, and >100 cm as 20. Females – individuals with waist circumference < 100 cm as 0, 101 -109 cm as 10, and ≥ 110 cm as 20.
3. *Family history of diabetes*: Subjects with no family history of diabetes were coded as 0, those with one diabetic parent scored as 10, those having both parents with diabetes as 20.
4. *Physical activity*: If individuals did leisure time exercise, and in addition had physically demanding occupations, they were coded scored as 0, individuals who either exercised or whose occupations were physically demanding were coded as 10, and those who did not exercise were coded as 20.

The following four simple questions and only one anthropometric measurement (viz., waist circumference) were used as information for the risk factors for diabetes:

1. How old are you?
2. Does your mother or father or both have diabetes?
3. Do you exercise regularly?
4. Is your occupation physically demanding?

Tables 2 and 3 were generated from these questions and the waist circumference data.

Table. 2 The Risk factors included in the development of a diabetes risk score.

Waist Circumference		
Gender		Score
Female	Male	
< 100 cm	< 90 cm	0
101 – 109 cm	91 – 99 cm	10
> 110 cm	> 100 cm	20

Table 3. Family History of Type 2 Diabetes and Physical Activity for developing risk scores

Family History	
No History	0
One Diabetic Parent	10
Both Parents are/were diabetic	20
Physical Activity	
I exercise regularly	0
I exercise sometime	20
Do not exercise at all	30

We constructed ROC curves to identify the optimal Diabetes Risk Score for detecting pre-diabetes/undiagnosed diabetes (Lindstrom & Tuomilehto, 2003) (10) in the Eastern Cape using HOMA-IR and waist circumference cutoffs. The sensitivity was plotted on the y-axis and the false –positive rate (1-specificity) on the X axis. On the ROC curve, Youden index *J.* is the point on the curve that is farthest from the chance line (Schisterman, et al. 2005) (11). First introduced by Youden, the Youden index *J* evaluates biomarker effectiveness (Zhou & Qin, 2012) (12). The larger the area under the curve (AUC) the more accurately discriminating the test and the steeper the upward portion of the ROC curve; the optimal cut-point being the peak of the curve (Silman, et al. 1995) (13). In this study, the statistical significance of the discriminatory power of the DRS was declared if a two-sided *P* value ws less than 0.05. All computations were performed using the Statistical Package for Social Sciences, version 23.0 SPSS Inc., Chicago Il, USA.

Results

Figures 1 and 2 show the ROC curves displaying the areas under the curves which illustrate the prediction of a diabetes risk score for undiagnosed females and males.

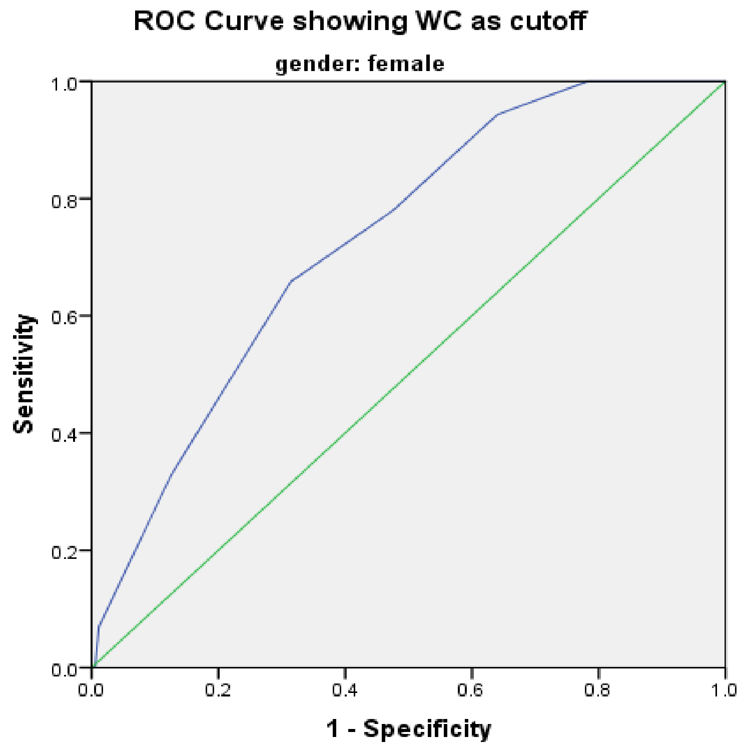

Figure 1. ROC showing the prediction of the Diabetes Risk Score for women

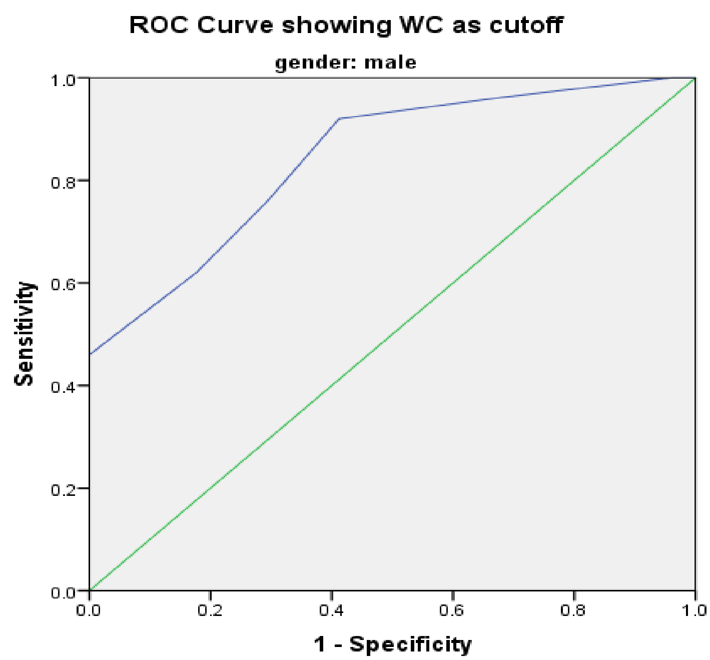

Figure 2. ROC showing the prediction of the Diabetes risk score for Men.

Table 4. Area Under the Curve Using Waist Circumference as Cutoff.

Gender	Area Under the Curve	Std Error	*P*-Value	95% Confidence Interval	
				Lower Bound	Upper Bound
Male	.842	.038	.000	.768	.917
Female	.730	.027	.000	.676	.783

Table 5. Diabetes Risk Scores Using Waist Circumference as Cutoff

Gender	Diabetes Risk Sore	Sensitivity	1 – Specificity	J
Male	9.0	1.000	1.000	
	15.0	1.000	.962	.038
	25.0	.962	.673	.289
	35.0	.923	.423	.25
	45.0	.769	.388	.381
	55.0	.635	.273	.362
	65.0	.462	.000	.462
	75.0	.231	.000	.231
	85.0	.096	.000	.096
	91.0	.000	.000	.00
Female	19.0	1.000	1.000	.00
	25.0	1.000	.910	.09
	35.0	1.000	.785	.215
	45.0	.945	.638	.307
	55.0	.776	.475	.301
	65.0	**.661**	**.316**	**.345**
	75.0	.333	.130	.203
	85.0	.073	.011	.062
	95.0	.000	.006	-
	101.0	.000	.000	-

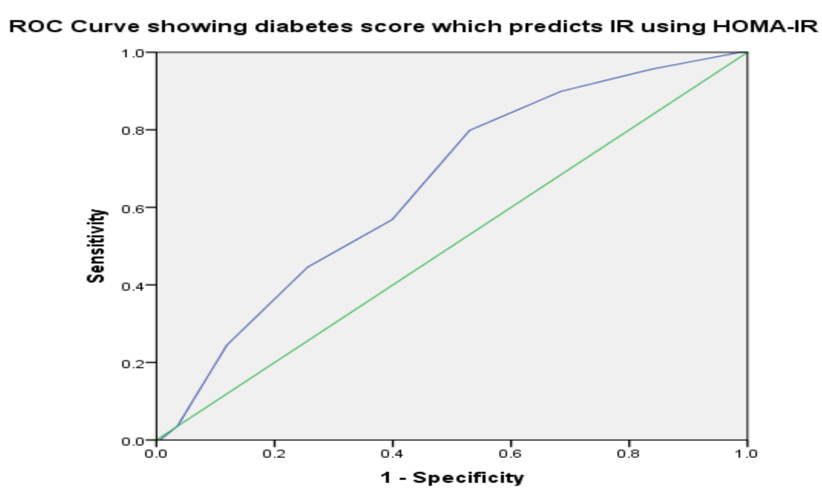

Figure 3. ROC determining the diabetes risk score for the sample, that predicts insulin resistance using HOMA-IR as cutoff.

Table 6. Area Under the Curve for HOMA-IR as Cutoff

Area Under the Curve	Std. Error	*P* - Value	95% Confidence Interval	
			Lower Bound	Upper Bound
.748	.023	.000	.703	.793

Table 7. Diabetes Risk Scores Using HOMA-IR as Cutoff

Diabetes Risk Score	Sensitivity	1 – Specificity	*J*
9.0000	1.000	1.000	
15.0000	1.000	.991	.009
25.0000	.990	.854	.136
35.0000	.981	.699	.282
45.0000	.899	.562	.337
55.0000	.740	.407	.333
65.0000	**.611**	**.243**	**.368**
75.0000	.303	.097	.206
85.0000	.077	.009	.068
95.0000	.000	.004	
101.0000	.000	.000	

The Youden index, *J* was estimated by subtracting (1-Specificity) from Sensitivity. The DRS value with the highest difference was interpreted as the optimal DRS for predicting pre-diabetes/undiagnosed diabetes. Table 5 shows that in separate analyses, the optimal DRS is 65 for both men and women when waist circumference is the cutoff. Table 7 shows that for the entire sample, the optimal DRS score is also 65 when HOMA-IR is cu the cutoff. If DRS is raised to 70, it means that there will be an increase in false negatives. Because of the serious implications of this study, we feel that it is prudent to be liberal on the side of including more people who would be considered vulnerable, into a potential sample, instead of over-looking people that could be pre-diabetic/diabetic. We would therefore rather have more false positives than false negatives. In the interest of this logic, the score is arbitrarily lowered to 60. Since this study utilized a convenience sample consisting of individuals visiting Community Health Centers, we feel that there is a need to repeat the study on a representative sample of the provincial population.

Conclusion.

From our study we report that the Diabetes Risk Score for the Eastern Province of South Africa is 60.

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Conflict of Interest: the authors declare no potential conflict of interest

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