Letter to the Editor

A Better Instrument for Screening Diabetes in Rural Areas of China: An Equation Developed from Multivariate Logistic Regression or a Simplified Scoring Form*

ZHAO Xiao Long[1,Δ], HE Xiao Ye[2,Δ], ZHANG Heng Sheng[3], LU Bin[1], LI Jin Hui[3], LI Yi Ming[1], ZHOU Li Nuo[1,#], and HU Ren Ming[1]

Diabetes has become a major public health concern in the world and the total number of diabetic patients is considered to soar to 366 million in 2030[1]. Emerging evidence has suggested that earlier detection of type 2 diabetes, glycaemic control improvement and intensified risk factor management may result in clinically important improvements in diabetes-related morbidity and mortality[2-3]. According to the World Health Organization (WHO), strategies such as clinical questionnaires, urine glucose, blood glucose, glycated haemoglobin A1C (HbA1C) and combinations of the above tests can be used for screening diabetes[4]. Although the oral glucose tolerance test (OGTT) is currently the gold standard for diagnosing dysglycaemia defined as impaired fasting glucose, impaired glucose tolerance and previously undiagnosed diabetes, it is neither simple and cheap enough nor acceptable for routine clinical use, especially in the rural regions where the OGTT could not be able to perform regularly because of limited medical resources and financial supports. Since there is no consensus of a more effective, efficient and cost-effective method for screening diabetes, we try to develop a quick, easy, non-invasive and inexpensive method for identifying individuals with diabetes.

This study was approved by the institutional review board of the Songming Health Bureau, Yunnan Province and the Human Research Ethics Committee, Huashan Hospital of Fudan University, Shanghai. On the first stage, a total of 993 subjects without a history of diabetes in a population-based, cross-sectional study in Songming County, southwest rural area of Yunnan Province, China from June 2010 to September 2010[5] were taken as research objects. Anthropometric measurements included height, weight, waist circumference and hip circumference were taken for all the participants. Body mass index (BMI) and waist to hip ratio (WHR) was calculated after the measurement. The OGTT was undertaken after at least 10 h of overnight fasting for all the participants and the WHO diagnostic criteria were used to diagnose diabetes[6]. Personal information was collected by trained nurses using a questionnaire including socio-demographic characteristics, lifestyle behavior, different anthropometric indices, and personal and family histories of diseases and hospitalizations.

Multivariate logistic regression analysis was used to develop an equation to predict diabetes. The panel of risk factors used in logistic regression analysis in our study was age, sex, BMI, WHR, systolic blood pressure, diastolic blood pressure, family history of diabetes, history of fasting or postprandial dysglycaemia and history of dyslipidemia. The variables with $P<0.2$ in the multivariate logistic regression analysis were selected for the items in the simplified scoring form (Table 1).

The simplified scoring form we designed as well as the two scoring methods was shown in Table 2. The form was fulfilled and the scores were calculated after questionnaire. The scores (Method 1) of this form were calculated as follows: 2 for age ≥45 years and 0 for age<45 years; -1 for WHR<0.85 (male) or <0.80 (female), 0 for WHR 0.85-0.95 (male) or 0.80-0.90, 5 for WHR >0.95 (male) or >0.90 (female); 2 for positive history of dysglycaemia and 0 for negative history of dysglycaemia; 1 for positive history of dyslipidemia and 0 for negative history of dyslipidemia; 2 for positive family history of diabetes and 0 for negative family history of diabetes. In another scoring method (Method 2), the scores were obtained from multiplied the β coefficient by a factor of 10, whereby

doi: 10.3967/0895-3988.2013.06.011

1.Department of Endocrinology & Metabolism, Huashan Hospital, Shanghai Medical College of Fudan University, Shanghai 200040, China; 2.Department of Geriatrics, the Affiliated Zhongshan Hospital of Fudan University, Shanghai 200032, China; 3. Internal Medicine Department, People's Hospital, Songming County, Kunming 651700, Yunnan, China

Table 1. The Results of Logistic Regression Analysis for Five Variables of the Simplified Scoring Form

Variable	β Coefficient	Odds Ratio	95% CI		*P* Value
Age ≥45	0.4813	2.618	1.206	5.683	0.0149
WHR* Medium exposure group	-0.3062	1.161	0.564	2.390	0.0675
High exposure group	0.7615	3.377	1.600	7.126	<.0001
The family history of diabetes (parents or siblings) Yes	0.3138	1.873	0.783	4.481	0.1584
History of fasting or postprandial dysglycaemia Yes	0.5663	3.103	1.919	5.019	<.0001
History of dyslipidemia Yes	0.2770	1.740	0.990	3.059	0.0542

Note. *The WHR was divided in to three groups according to the standard as follows: the control group: male<0.85, female<0.8; medium exposure group: male 0.85-0.95, female 0.8-0.9; high exposure group: male≥0.95, female≥0.9. The variables with *P*>0.2 in the multivariate logistic regression analysis were excluded in Table 2.

Table 2. Two Scoring Methods Used in the Simplified Scoring Form

Items		Method 1	Method 2(β coefficient ×10)
Age	≥45 years	2	4.8
	<45 years	0	0
WHR	male<0.85 female<0.80	-1	-4.1
	male:0.85-0.95 female:0.80-0.90	0	0
	male>0.95 female>0.90	5	7.6
History of dysglycaemia	Yes	2	5.6
	No	0	0
History of dyslipidemia	Yes	1	2.7
	No	0	0
Family history of diabetes	Yes	2	3.1
	No	0	0
Total scores		11	19.7

the β coefficient was derived from multivariate logistic regression analysis of the risk factors[7]. Previous records of fasting glucose level ≥6.1 mmol/L or 2-hour glucose level ≥7.8 mmol/L, or both were considered positive history of dysglycaemia. Positive history of dyslipidemia refers to the previous records of any abnormal lipid profile such as triglycerides ≥150 mg/dL, total cholesterol ≥200 mg/dL, high-density lipoprotein-cholesterol <40 mg/dL in men and <50 mg/dL in women or low-density lipoprotein-cholesterol ≥130 mg/dL according to National Cholesterol Education Program Adult Treatment Panel-3 (NCEP-ATP-3) guidelines[8]. Those participants with one or more siblings or parents who had a history of diagnosed diabetes were considered as the ones with positive family history of diabetes.

Receiver operating characteristic (ROC) curve was constructed to select the optimal cut-off point for defining a positive test and the area under the ROC between two scoring methods was compared by Z test. The Kappa test was performed to test the consistence of the two scoring methods. Our results showed that with the sensitivity of 61%, specificity of 76.1% for scoring method 1 and sensitivity of 62.7%, specificity of 75.8% for scoring method 2, both methods had good value in screening diabetes (Figure 1A). According to the optimal cut-off point of ROC curve, subjects with scores ≥3.5 may have diabetes if the scoring method 1 was used for the simplified scoring form, while those with scores ≥ 7.55 may have diabetes if the scoring method 2 was used. The areas under the ROC curve of the method 1 and 2 were 0.749 and 0.696 respectively, and the Z test showed that there were no significant differences between the two scoring methods. The Kappa coefficient of the two methods was 0.81 indicating a great consistence between the two scoring methods. In order to validate the value and efficiency of the simplified scoring form for screening diabetes, the form was then performed in another population of 962 subjects from Baoshan District of Shanghai on the second stage of our study. The ROC curve showed that the two scoring methods still had good value in screening diabetes and meanwhile, there was a great consistence between method 1 and method 2 with the Kappa coefficient of 0.95 (Figure 1B).

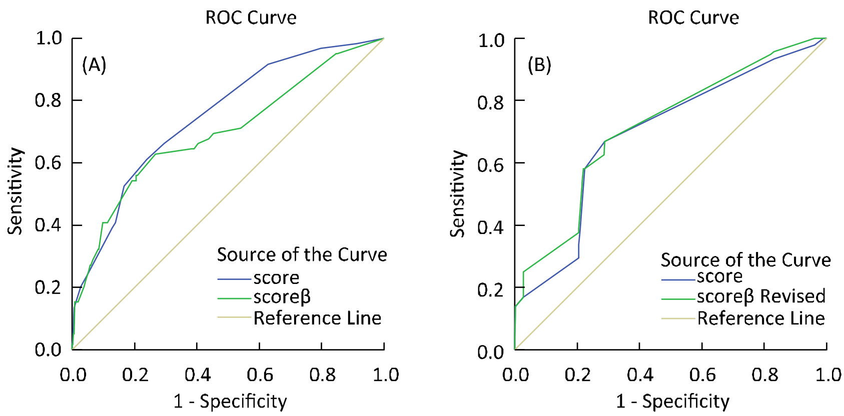

Figure 1A~B. ROC curves of two different scoring methods from the population of Songming county or Baoshan district. (A) the population from Songming county of Yunnan; (B) the population from Baoshan district of Shanghai; Blue line-scoring method 1; Green line-scoring method 2 (scoring method developed from predictive equation, **β** Coefficient ×10); Brown line-Reference line.

As a developing country with the largest population in the world, the problem of uneven economic development between areas is still obvious in China. Although the age- and sex-adjusted prevalence rates of diabetes did not differ significantly between urban and rural residents in the economically developed regions of China, the prevalence of pre-diabetes was higher among rural residents[9]. However, in rural regions where more than 60% of the Chinese population lives in, many people may have no chance to undertake OGTT for diagnosis of diabetes. This could result in the delay of diagnosis and treatment, and more incidence of diabetes related complications. Therefore, an easy, cheap and convenient screening method which is suitable for large-scale epidemiological survey especially for rural areas is required. The simplified scoring form we designed in this study is quite easy to understand. All the scores of risk factors including age, WHR, history of dysglycaemia, history of dyslipidemia and family history of diabetes in the form can be easily determined and quickly calculated during clinical interview. The validation of comparing the two scoring methods for subjects from two different populations showed the repeatability, reliability and good value of the simplified scoring form in screening diabetes in different populations. Therefore, we recommended the use of the simplified scoring form for primary screening of diabetes in the rural areas of China. Since the Z test results showed that there was no significant difference between the areas under the ROC curves of the two scoring methods in the two different populations, the scoring method 1 should be given priority to be applied due to its convenience and easier scoring than method 2. Of course, to avoid overlooking individuals with persistent or progressive dysglycaemia, periodic rescreening, blood tests or OGTT should be performed whenever necessary.

ACKNOWLEDGEMENTS

We sincerely thank MPH DING Yong Gang for his statistic analysis support.

*This work was supported by the National Natural Science Foundation of China (30700385), the China Postdoctoral Science Foundation (20070410690) and the Postdoctoral Fund of Shanghai Committee of Science and Technology.

ΔZHAO Xiao Long and HE Xiao Ye contributed equally to this work.

#Correspondence should be addressed to ZHOU Li Nuo (Ph.D., Professor). Tel: 52889999. Fax: 62489191. E-mail: linuo_zhou@163.com

Received: May 21, 2012;

Accepted: October 21, 2012

REFERENCE

1. Wild S, Roglic G, Green A, et al. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. Diabetes Care, 2004; 27, 1047-53.
2. Engelgau MM, Venkat Narayan KM, Herman WH. Screening for type 2 diabetes. Diabetes Care, 2000; 23, 1563-80.
3. Colagiuri S, Cull CA, Holman RR. The UKPDS Group. Are lower fasting plasma glucose levels at diagnosis of type 2 diabetes

associated with improved outcomes. UK Prospective Diabetes Study 61. Diabetes Care, 2002; 5, 1410-7.
4. World Health Organization. Screening for Type 2 Diabetes: Report of a World Health Organization and International Diabetes Federation Meeting. 2003.
5. Zhao X, Zhu X, Zhang H, et al. Prevalence of diabetes and predictions of its risks using anthropometric measures in southwest rural areas of China. BMC Public Health, 2012; 24, 821.
6. World Health Organization. Definition, diagnosis and classification of diabetes mellitus and its complications. Report of a WHO Consultation. Part 1: Diagnosis and classification of diabetes mellitus. WHO Technical Report Series, 1999; 344, 1-59.
7. Spijkerman A, Griffin S, Dekker J, et al. What is the risk of mortality for people who are screen positive in a diabetes screening programme but who do not have diabetes on biochemical testing? Diabetes screening programmes from a public health perspective. J Med Screen, 2002; 9, 187-90.
8. National Cholesterol Education Program (NCEP). Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. Circulation, 2002; 106, 3143-421.
9. Yang W, Lu J, Weng J, et al. Prevalence of diabetes among men and women in China. N Engl J Med, 2010; 62, 1090-101.