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Screening Strategy for Type 2 Diabetes in the United Arab Emirates

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Abstract

The prevalence of type 2 diabetes mellitus (DM) among Emirati nationals is one of the highest in the world. The recently released United Arab Emirates National DM guidelines call for screening all adults aged 30 years and more. The authors explored the need for such a modification of current American Diabetes Association (ADA) guidelines. They also considered the prevalence rates for undiagnosed DM based on oral glucose tolerance test (OGTT) versus glycohemoglobin (HbA_{1c}) ≥ 6.5% in a population-based sample of 296 adult Emirati participants. In the low-risk ADA category, defined by age <45 years and BMI <25, only 1 of 68 (1.5%) participants was diagnosed with DM. The overall rate of DM based on HbA_{1c} was lower than that based on OGTT (10.1% versus 14.2%; $P < .05$). The authors conclude that the ADA guidelines are adequate for screening in this high-risk population. They also find high discordance between HbA_{1c} and OGTT.

Keywords

prevalence, diabetes mellitus, HbA_{1c}, oral glucose tolerance test, United Arab Emirates

Introduction

The prevalence of type 2 diabetes mellitus (DM) among Emiratis is one of the highest in the world.[1,2] The most common explanations for the high rate of DM in the United Arab Emirates (UAE) and other Gulf countries relate to their rapid economic development with abundant food and decreased opportunity and motivation for physical activity, acting on genetically susceptible individuals.[3,4] The appropriate screening strategy for DM in this high-risk population remains to be established, however. The recently released UAE National DM screening guidelines call for screening all adults aged 30 years and more. In contrast, the American Diabetes Association (ADA) guidelines call for screening all adults aged 45 years and more or those who are overweight and have 1 additional risk factor (such as high-risk ethnic population).[5] We explored the need for modifying the ADA

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guidelines in this high-risk population. We also considered the prevalence rates for undiagnosed DM based on fasting blood sugar (FBS) level and oral glucose tolerance test (OGTT) versus glycohemoglobin (HbA_{1c}), given the recent proposal on the use of HbA_{1c} for the diagnosis of DM.[5-7] Our results may provide important information for planning of services and determining the effectiveness of population-based interventions.

Methods

Participants

Participants took part in a cross-sectional, population-based study about the prevalence of diabetes and its complications in Al Ain, UAE, as described in detail elsewhere.[2] The study was designed to enrol 100 participants with DM to estimate the prevalence of any complication that occurs in 50% of participants with DM with a standard error of 0.05. With a prevalence rate of DM in the adult population of 25%,[1] we targeted a total sample size of 400 participants. A random sample of 600 houses of Emirati citizens living in Al Ain, UAE, was selected, the excess being to allow for nonparticipation. Of the 600 houses in the selected sample, 575 houses were approached; 25 houses were in very remote areas and were therefore excluded. Of the 575 houses surveyed, 452 were occupied, and household heads provided information. Of these 452 houses, 381 agreed to further participation. However, from only 194 houses, a total of 373 household members agreed to undergo testing. Participants reported to the clinic in the morning after an overnight (8-16 hours) fast. A standardized questionnaire on demographic data, physical activity, tobacco use, health status, diabetic neuropathy symptoms, medication use, and cardiovascular symptoms was administered by an experienced bilingual nurse. Height, weight, and waist circumference were measured with the participants wearing light clothing and no shoes. Body mass index (BMI) was calculated as body weight in kilograms divided by the square of height in meters (kg/m^2). Participants were considered to have (known) diabetes if they reported a previous medical diagnosis of diabetes and/or were using antidiabetic medications. Fasting blood glucose was initially determined by use of a glucose meter, and an OGTT was performed in participants without a history of DM if the blood glucose as measured by the glucose meter was <7 mmol/L. The study was approved by the Al Ain Medical District Human Research and Ethics Committee.

Laboratory Measurements

Fasting venous blood samples were collected from all participants for determination of serum glucose (FBS) and blood chemistry, HbA_{1c}, and lipid profile. For the OGTT, participants were requested to drink, within the space of 5 minutes, 75 g anhydrous glucose dissolved in 250 mL water. Samples were processed within 30 minutes of collection, and the above laboratory tests were measured on a Beckman Coulter DXC800 (Beckman Instruments, Inc; Fullerton, CA) autoanalyzer at the central laboratory of Tawam hospital, a tertiary hospital in Al Ain.

Data Processing and Analysis

Data were analyzed using SPSS version 17 (SPSS Inc, Chicago, IL). Standard descriptive statistics were used. Differences among groups were analyzed using McNemar's test. DM was defined according to the WHO expert group[8]: that is, FBS ≥ 7.0 mmol/L and/or 2-hour post-OGTT venous blood glucose concentration ≥ 11.1 mmol/L. Prediabetes status was based on the presence of impaired FBS (5.6-6.9 mmol/L) or impaired glucose tolerance (2-hour post-OGTT of 7.8-11.0 mmol/L). HbA_{1c} categories were ≥ 6.5% (DM), 5.7% to <6.5% (increased risk for diabetes or prediabetes),

Table 1. Frequencies of Undiagnosed DM by Risk Category in a Population-Based Sample of 296 Adult Emirati Participants Not Known to Have DM

Risk Category[a]	DM Based on OGTT and HbA_{1c}	DM Based on OGTT Alone	DM Based on HbA_{1c} Alone	No DM by Both Criteria	Total
Low risk	0	1	0	67	68
High risk	25	16	5	182	228
Total	25	17	5	249	296

Abbreviations: DM, diabetes mellitus; HbA_{1c}, glycohemoglobin; OGTT, oral glucose tolerance test.
[a]Low risk: age < 45 years and BMI < 25 kg/m^2; high risk: age ≥ 45 years or BMI ≥ 25 kg/m^2.

Table 2. Association Between HbA_{1c} and OGTT Risk Category in a Population-Based Sample of 296 Adult Emirati Participants Not Known to Have DM

HbA_{1c}/OGTT Risk Category	Normoglycemia	Prediabetes	DM	Total
HbA_{1c} < 5.7%	125	36	4	165
HbA_{1c} 5.7 to < 6.5%	53	35	13	101
HbA_{1c} ≥ 6.5%	3	2	25	30
Total	181	73	42	296

Abbreviations: HbA_{1c}, glycohemoglobin; OGTT, oral glucose tolerance test; DM, diabetes mellitus.

and <5.7% (low risk for diabetes).[5,6] The high-risk category was based on the ADA guidelines (defined by age ≥45 years or BMI ≥25 kg/m^2 and 1 additional risk factor such as high-risk ethnic population).[5] FBS/OGTT strategy (ie, performing OGTT in those with FBS <7 mmol/L) was used as the gold standard.

Results

Of the 373 participants who underwent testing, 296 were eligible for this analysis. The reasons for not including the others were known diabetes in 59, missing HbA1c levels in 8, and no OGTT test performed despite a FBS < 7 mmol/L in 10 participants. A total of 27 participants had FBS > 7 mmol/L and therefore did not undergo OGTT. Table 1 shows the frequencies of undiagnosed DM by ADA risk category based on FBS/OGTT and HbA_{1c}. Of the 296 participants, 68 (23%) were in the low-risk ADA category, defined as age < 45 years and BMI < 25 kg/m^2, and 228 (77%) were in the high-risk ADA category. In the low-risk ADA category, only 1 out of 68 (1.5%) participants was diagnosed with DM based on FBS/OGTT and none based on HbA_{1c}. In the whole group, FBS/OGTT and HbA_{1c} were concordant for the diagnosis of DM in 25 participants (59.5%).

Based on FBS/OGTT, 181 (61.1%) had normoglycemia, 73 (24.7%) had prediabetes, and 42 (14.2%) had undiagnosed DM (Table 2). Based on HbA_{1c}, 165 (55.8%) had low risk, 101 (34.1%) had prediabetes, and 30 (10.1%) had undiagnosed DM. The overall rate of DM based on HbA_{1c} was lower than that based on FBS/OGTT (10.1% vs 14.2%; $P < .05$ by McNemar's test). Figure 1 shows the correlation between FBS and HbA_{1c} marked by undiagnosed diabetes (based on FBS/OGTT). In all, 12 out of 42 (28.6%) cases would have been missed if only HbA1c was used as the screening test for diabetes. Figure 2 shows the receiver-operating characteristic plot, representing the sensitivity and specificity of HbA_{1c} and FBS/OGTT in detecting undiagnosed diabetes. For a cutoff value of HbA_{1c} of 6.5% (with FBS/OGTT as the gold standard), the sensitivity is only about 0.55 (specificity is high, though, at 0.98). Lowering the cutoff value of HbA_{1c} to 6.0% increases the sensitivity to 0.74, and the specificity is still acceptable at 0.85.

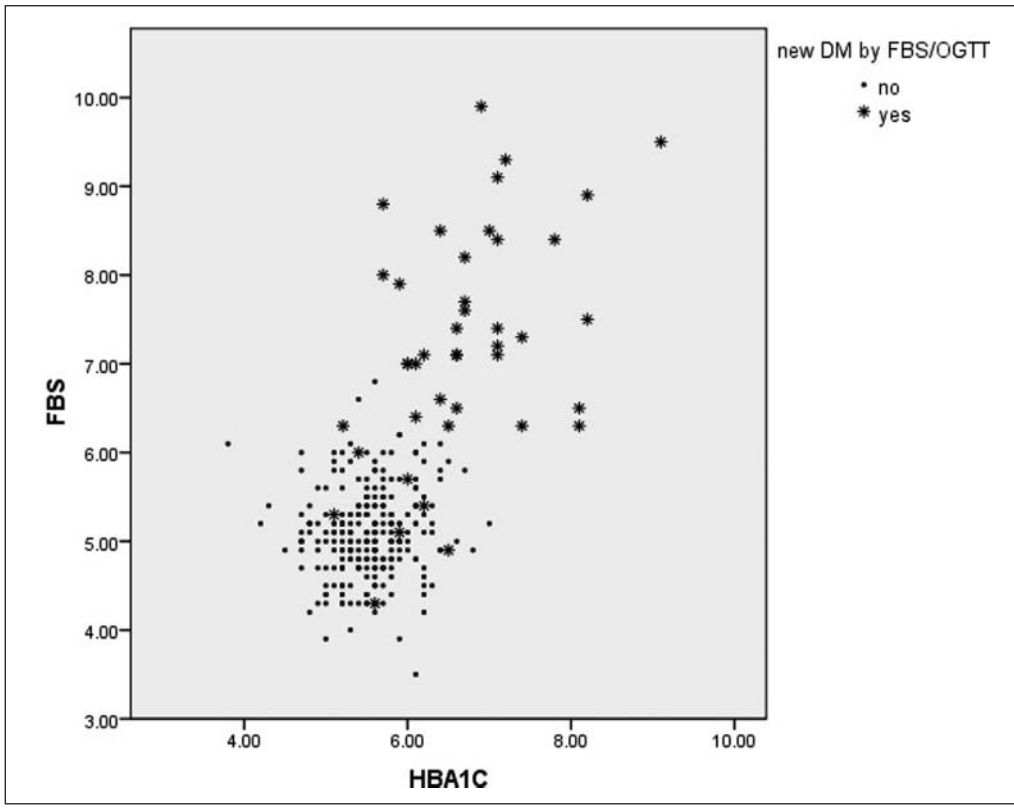

Figure 1. Correlation between FBS and HbA_{1c} marked by undiagnosed diabetes (based on FBS/OGTT)
Abbreviations: FBS, fasting blood sugar; HbA_{1c}, glycohemoglobin; OGTT, oral glucose tolerance test.

Discussion

Our data suggest that the current ADA guidelines are adequate for screening in this high-risk population. This is probably related to the low cutoff point for BMI (≥25 kg/m^2) recommended by the ADA for screening (in the presence of 1 additional risk factor such as high-risk ethnic population).[5] Lowering the age of screening to 30 years, as recommended by the recently released UAE National guidelines, would likely identify only a few more cases of diabetes and therefore would not be a cost-effective strategy. We have no data on whether in the UAE, community screening should be recommended or whether screening should be carried out within the health care setting and targeting high-risk individuals, as recommended by ADA.[5] Community screening outside a health care setting is not recommended by the ADA because people with positive tests may not seek, or may not have access to, appropriate follow-up testing and care. Conversely, there may be failure to ensure appropriate repeat testing for individuals who test negative.[5] Community screening may also be poorly targeted, that is, it may fail to reach the groups most at risk and inappropriately test those at low risk (28% in our study) or even those already diagnosed.[9,10] All these arguments appear to be as relevant for the UAE as for the United States.

Recently, an International Expert Committee recommended the use of the HbA_{1c} test to diagnose diabetes, with a threshold of ≥6.5%.[6] This was supported by position statements from ADA[5] and the American Academy of Endocrinology.[7] Earlier studies have also advocated the use of HbA_{1c} as a screening test for undiagnosed diabetes.[11,12] HbA_{1c} has several advantages over FBS and OGTT, including greater convenience, because fasting is not required; possibly greater preanalytical

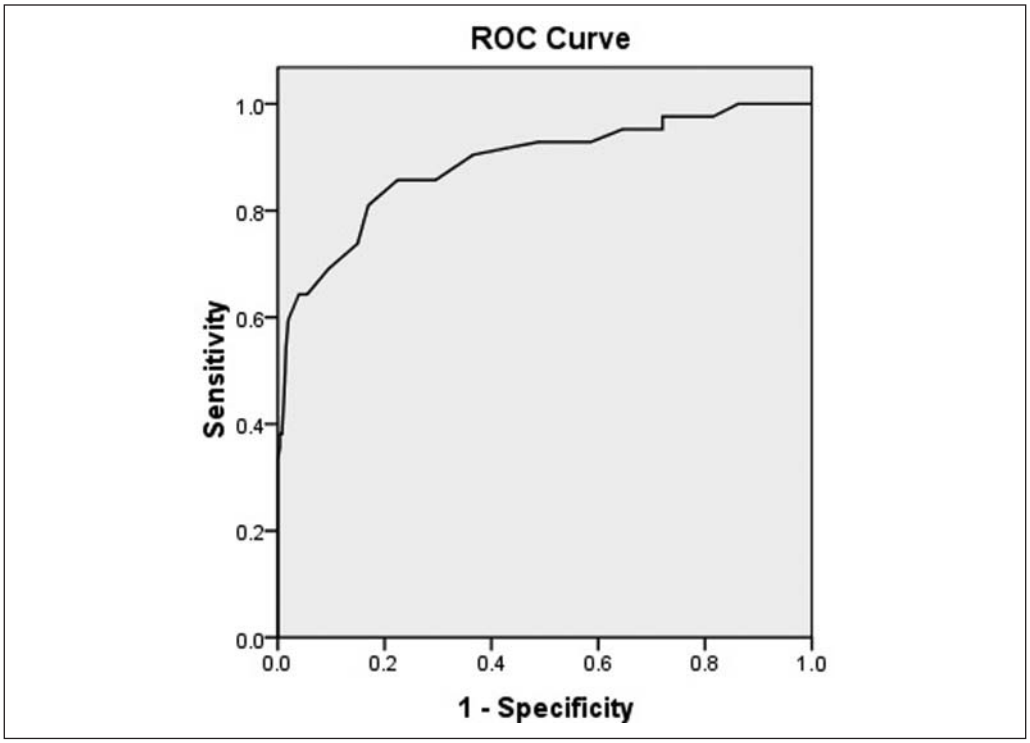

Figure 2. Association between HbA_{1c} and FBS among diabetics and nondiabetics by FBS/OGTT; area under receiver-operating characteristic curve = 0.89
Abbreviations: HbA_{1c}, glycohemoglobin; FBS, fasting blood sugar; OGTT, oral glucose tolerance test.

stability; and less day-to-day variation during periods of stress and illness.[5] These advantages must be balanced against greater cost, limited availability in the developing world, and imperfect correlation between HbA_{1c} and average glucose in certain individuals.[5] In addition, HbA_{1c} can be misleading in patients with hemolysis, iron deficiency anemia, and hemoglobinopathies (common in the UAE), and the methodology also needs to be standardized to the Diabetes Control and Complications Trial reference assay.[5] Our data show a high discordance between OGTT and HbA_{1c} and suggest that $HbA_{1c} \geq 6.5\%$ may underestimate the prevalence of DM compared with OGTT in this population. Analyses of National Health and Nutrition Examination Survey data indicate that HbA_{1c} of ≥6.5% identifies one third fewer cases of undiagnosed DM than a fasting glucose of ≥7.0 mmol/L.[5] HbA_{1c} could therefore be used for initial screening in this population, with the caveat that when HbA_{1c} is 6.0 to <6.5%, FBS/OGTT may be necessary. Factors that may result in high discordance between HbA_{1c} and OGTT in this population include high rate of hemoglobinopathy and iron deficiency anemia. For patients with a hemoglobinopathy, it is recommended that an HbA_{1c} assay without interference from abnormal hemoglobins should be used. For conditions with abnormal red cell turnover, such as pregnancy or anemia from hemolysis and iron deficiency, it is recommended that the diagnosis of diabetes should be based on glucose criteria exclusively.[5]

Conclusion

Our data suggest that the current ADA guidelines are adequate for screening in this high-risk population. We also found a high discordance between OGTT and $HbA_{1c} \geq 6.5\%$ for the diagnosis of DM. HbA_{1c} could be used for initial screening in this population with the caveat that when HbA_{1c}

is 6.0 to <6.5%, or when hemoglobinopathy and iron deficiency anemia are encountered, FBS/OGTT may be necessary. The development of a methodology to prevent diabetes on a population-wide basis is in its infancy throughout the world at the present time. Although much work has been done in this area in the UAE, lifestyle changes aiming at the reduction of the risks for obesity and diabetes will likely be the greatest challenge to UAE health care leaders and community partners and will require close collaboration between the public and private sectors, including within schools, where exercise habits are often developed.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the authorship and/or publication of this article.

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References

1. Malik M, Bakir A, Abi Saab B, Roglic G, King H. Glucose intolerance and associated factors in the multi-ethnic population of the United Arab Emirates: results of a national survey. *Diabetes Res Clin Pract*. 2005;69:188-195.
2. Saadi H, Carruthers SG, Nagelkerke N, et al. Prevalence of diabetes mellitus and its complications in a population-based sample in Al Ain, United Arab Emirates. *Diabetes Res Clin Pract*. 2007;78:369-377.
3. Carter A, Saadi H, Reed RL, Dunn EV. Obesity, lifestyle and reproductive health in a representative sample of women citizens of Al Ain, United Arab Emirates. *J Health Popul Nutr*. 2004;22:75-83.
4. Saadi H, Nagelkerke N, Carruthers SG, et al. Association of TCF7L2 polymorphism with diabetes mellitus, metabolic syndrome, and markers of beta cell function and insulin resistance in a population-based sample of Emirati subjects. *Diabetes Res Clin Pract*. 2008;80:392-398.
5. American Diabetes Association. Standards of medical care in diabetes: 2010. *Diabetes Care*.2010; 33(suppl 1):S11-S61.
6. International Expert Committee. International Expert Committee report on the role of the A1C assay in the diagnosis of diabetes. *Diabetes Care*. 2009;32:1327-1334.
7. American Association of Clinical Endocrinologists Position Statement. American Association of Clinical Endocrinologists approves new diagnosis for diabetes. http://media.aace.com/article_display.cfm?article_id=4942. Published February 1, 2010. Accessed February 9, 2010.
8. *World Health Organization, Definition, Diagnosis and Classification of Diabetes Mellitus and its Complications. Report of a WHO Consultation, WHO/NCD/NCS/99.2*. Geneva, Switzerland: World Health Organization; 1999.
9. Harris R, Donahue K, Rathore SS, Frame P, Woolf SH, Lohr KN. Screening adults for type 2 diabetes: a review of the evidence for the U.S. Preventive Services Task Force. *Ann Intern Med.* 2003;138:215-229.
10. U.S. Preventive Services Task Force. Screening for type 2 diabetes mellitus in adults: recommendations and rationale. *Ann Intern Med.* 2003;138:212-214.
11. Zhang P, Engelgau MH, Valdez R, Cadwell B, Benjamin SM, Venkat Narayan KM. Efficient cut-off points for three screening tests for detecting undiagnosed diabetes and pre-diabetes. *Diabetes Care.* 2005;28:1321-1325.
12. Bennett CM, Guo M, Dharmage SC. HbA1c as a screening tool for detection of type 2 diabetes: a systematic review. *Diabet Med*. 2007;24:333-343.