

DIABETES IN OMAN: COMPARISON OF 1997 AMERICAN DIABETES ASSOCIATION CLASSIFICATION OF DIABETES MELLITUS WITH 1985 WHO CLASSIFICATION

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Background: Diabetes mellitus (DM) is a major public health problem in Oman. We evaluated the impact of the revised diagnostic criteria for DM adopted by the American Diabetes Association (ADA) on the prevalence of diabetes and impaired glucose tolerance (IGT), and on the classification of individuals among the Omani population.

Subjects and Methods: We used the dataset of the National Diabetes Survey, conducted in 1991 and involving 4682 subjects who did not have any missing data on fasting and 2-hour glucose. The subjects comprised 2002 males and 2680 females aged 20 years or above. Data were analyzed using the ADA criteria (diabetes as fasting plasma glucose [FPG] ≥ 7 mmol/L, impaired fasting glucose [IFG] as FPG ≥ 6.1 mmol/L and < 7 mmol/L), and compared these with the World Health Organization (WHO) criteria (diabetes as FPG ≥ 7.8 mmol/L and/or 2-hour post-glucose load ≥ 11.1 mmol/L, IGT as FPG < 7.8 mmol/L, and 2-hour post-load 7.8-11.1 mmol/L).

Results: Applying the ADA criteria on the Omani population resulted in an overall reduction of diabetes prevalence by 2.2% (95% confidence interval [CI] 1.6% to 2.8%), and a 4.8% reduction of IGT (95% CI 3.8% to 5.8%). Over 29% of diabetics classified by the WHO criteria were reclassified as being normal or having IFG by the ADA criteria. Around 3.6% of those who were normoglycemic by the WHO criteria were classified as having diabetes or IFG by the ADA criteria. In all but one region of Oman, the prevalence of diabetes and IFG using the ADA criteria was lower compared to the prevalence using the WHO criteria. Gender, age and body mass index did not seem to pose an increased risk to the probability of being diagnosed by one criteria or the other or both together.

Conclusion: The adoption of the ADA criteria in Oman will significantly reduce the prevalence of diabetes and IGT. In addition, the glycemic status of a substantial number of individuals will be changed from normal to either being diabetic or having IGT.

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Key Words: Diabetes, prevalence, Oman, criteria.

Diabetes mellitus (DM) is a major public health problem world-wide. In 1997, the World Health Organization (WHO) estimated its global prevalence to be more than 135 million, and projections for the year 2025 estimate a 120% increase in the number of people with diabetes throughout the world.¹ Diabetes, predominantly non-insulin dependent diabetes mellitus (NIDDM), is also a significant public health problem in the Sultanate of Oman. In 1991, the Ministry of Health, in collaboration with the WHO, conducted a national survey to estimate the burden of DM and other cardiovascular disease risk factors in Oman. This survey, using the WHO recommended methodology and diagnostic criteria,² showed that 10% of the Omani

population aged 20 years or above have diabetes mellitus.³ A further 10% was shown to have impaired glucose tolerance (IGT).

In 1997, the American Diabetes Association (ADA) adopted the recommendations put forward by an Expert Committee on the Diagnosis and Classification of Diabetes Mellitus,⁴ which included modification of the diagnostic criteria suggested earlier by the National Diabetes Data Group⁵ and WHO.⁶ The new criteria suggest that for epidemiological studies of incidence and prevalence, a fasting plasma glucose of ≥ 7 mmol/L (126 mg/dL) could be used alone⁴ compared to the 2-hour post-glucose load value of ≥ 11.1 mmol/L (200 mg/dL) suggested by WHO for the diagnosis of diabetes mellitus.

These recent changes in the diagnostic criteria may have an impact on the prevalence rates in Oman, and subsequently on the planning process and the cost incurred to the health services for the management of this chronic condition. In addition, it may have bearing on the reclassification of individuals,^{7,8} as those with diabetes

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TABLE 1. Comparison of WHO and ADA diagnostic criteria.

1985 WHO Criteria*	1997 ADA Criteria**			WHO total (% prevalence)
	Normal	IFG	Diabetes	
Normal	3566	115	17	3698 (79%)
Row %	96.4	3.1	0.46	
Column %	88.6	43	4.4	
IGT	385	82	26	493 (10.5%)
Row %	78.1	16.6	5.3	
Column %	9.6	30.6	6.7	
Diabetes	75	71	345	491 (10.5%)
Row %	15.3	14.5	70.3	
Column %	1.9	26.5	89	
ADA total (% prevalence)	4026 (86%)	268 (5.7%)	388 (8.3%)	4682

*WHO criteria: diabetes as FPG ≥ 7.8 mmol/L and/or 2-hour post-load ≥ 11.1 mmol/L; IGT as FPG < 7.8 mmol/L and 2-hour post-load 7.8-11.1 mmol/L; normal as FPG < 7.8 mmol/L and 2-hour post-load < 7.8 mmol/L. **ADA criteria: diabetes as FPG ≥ 7 mmol/L; impaired fasting glucose (IFG) ≥ 6.1 mmol/L and < 7 mmol/L; normal as FPG < 6.1 mmol/L.

TABLE 2. Selected factors associated with disagreement of classification between WHO and ADA criteria for diagnosis of diabetes (numbers and percentage of subjects).

Variable	WHO criteria only (n=491)	ADA criteria only (n=388)	WHO and ADA criteria (n=345)	P-Value†
Sex				
Men (n=539)	209 (38)	178 (33)	152 (28)	0.618
Women (n=685)	282 (41)	210 (31)	193 (28)	
Age (years)*				
<50 (n=640)	255 (40)	206 (32)	179 (28)	0.715
50-64 (n=445)	173 (39)	142 (32)	130 (29)	
≥ 65 (n=388)	62 (16)	39 (1)	35 (9)	
BMI (kg/m ²)**				
<25 (n=388)	154 (40)	125 (32)	109 (28)	0.945
25-30 (n=440)	172 (39)	143 (32)	125 (28)	
≥ 30 (n=396)	165 (42)	120 (30)	111 (28)	

See footnote to Table 1 for diagnostic criteria of the WHO and ADA; *Missing for one; **BMI=body mass index=weight/height² (kg/m²); † χ^2 test.

according to the WHO criteria may be reclassified as normal or with impaired fasting glucose (IFG) by the ADA criteria and vice versa. In this report, we attempt to evaluate the impact of the new diagnostic criteria of diabetes mellitus and impaired glucose categories on the overall national and regional prevalence rates, based on reanalysis of the 1991 epidemiological survey.

Subjects and Methods

The details of the methodology implemented in the 1991 survey have been published elsewhere.³ In brief, the National Diabetes Survey was a cross-sectional household survey conducted in 1991. Over 4600 subjects aged 20 years and above were recruited. With the exception of subjects taking oral antidiabetic drugs or insulin, all others were given an oral glucose tolerance test (OGTT), as

recommended by WHO.² Fasting and 2-hour post-glucose load blood samples were collected and serum plasma was analyzed. For the purpose of this analysis, we used the database generated by the above-mentioned survey.

To compare the WHO and ADA criteria, all individuals were classified on the basis of venous fasting plasma glucose (FPG) concentration as ADA-diabetic (FPG ≥ 7.0 mmol/L), ADA-IFG (FPG ≥ 6.1 and < 7 mmol/L), and ADA-normal (FPG < 6.1 mmol/L).⁴ The corresponding WHO cut-off points were WHO-diabetic (FPG ≥ 7.8 and/or 2-hour post-load ≥ 11.1 mmol/L), WHO-IGT (FPG < 7.8 mmol/L and 2-hour post-load between 7.8-11.1 mmol/L), and WHO-normal (FPG < 7.8 mmol/L and 2-hour post-load < 7.8 mmol/L).

Statistical analysis was performed using Intercooled Stata software version 5 (Stata Corporation, College Station, Texas, USA) to obtain prevalence and cross-tabulations. The difference in the prevalence by WHO and ADA criteria was tested using McNemar's test. Although IFG and IGT are not identical, they were compared with each other.

Results

National Level

There were discrepancies in the prevalence of diabetes and IGT between the WHO and ADA criteria. Table 1 shows the cross-tabulation of all the survey cohort by WHO (rows) and ADA (columns) classification cut-off points. The prevalence of normoglycemia was 79% using the WHO criteria versus 86% by the ADA criteria ($P < 0.0001$). The prevalence of IGT by the WHO criteria was almost twice the IFG by the ADA criteria (10.5% versus 5.7%, respectively, $P < 0.0001$). The difference in the prevalence of diabetes was less profound (10.5% by the WHO criteria versus 8.2% by ADA, $P < 0.0001$).

Gender, age and body mass index were selectively investigated for association with the disagreement on the diagnosis of diabetes according to the WHO and ADA criteria (Table 2). However, none of these factors was found to be significantly associated with higher probabilities of being diagnosed by either WHO or ADA criteria or both.

Regional Level

Table 3 compares the prevalence of diabetes and IGT/IFG between different regions of Oman using the WHO and ADA criteria. With the exception of the Al-Dakhliya region, the prevalence of IGT was higher than the prevalence of IFG in all other regions of Oman. The difference ranged from -1.3% in Al-Dakhliya to 9.6% in Al-Dhahira, with an overall significant difference of 4.8% ($P < 0.0001$). Similarly, the regional differences in the prevalence of diabetes were higher considering the ADA cut-off points. However, these were less striking compared to IGT/IFG. With the exception of the Al-Dakhliya region,

TABLE 3. Prevalence of impaired glucose tolerance and diabetes mellitus according to WHO and ADA criteria, and change in the prevalence by region.

Region	Impaired Glucose Tolerance			P-value*
	WHO criteria (%)	ADA criteria (%)	Difference (95% CI)	
Muscat	11.8	5.6	6.2 (3.2 to 9.1)	0.0001
Dhofar	11.2	5.5	5.7 (3.0 to 8.4)	0.0001
Al-Dakhliya	8.2	9.5	-1.3 (-3.9 to 1.4)	0.323
Al-Sharqiya	10.9	5.1	5.8 (3.0 to 8.4)	0.0001
North Batinah	13.3	5.5	7.8 (3.8 to 11.7)	0.0001
South Batinah	8.5	7.0	1.5 (-1.7 to 4.5)	0.345
Al-Dhahira	13.6	4.0	9.6 (5.8 to 13.8)	0.0001
Musandam	7.8	2.2	5.6 (2.9 to 8.3)	0.0001
Total	10.5	5.7	4.8 (3.8 to 5.8)	0.0001

Region	Diabetes Mellitus			P-value*
	WHO criteria (%)	ADA criteria (%)	Difference (95% CI)	
Muscat	11.8	8.2	3.6 (1.6 to 5.4)	0.0001
Dhofar	10.5	7.6	2.9 (1.1 to 4.2)	0.0002
Al-Dakhliya	8.2	8.6	-0.4 (-1.9 to 1.1)	0.56
Al-Sharqiya	10.7	8.7	2.0 (0.5 to 3.4)	0.0025
North Batinah	10.8	9.4	1.4 (-0.7 to 3.3)	0.16
South Batinah	12.3	9.0	3.3 (1.2 to 5.2)	0.0006
Al-Dhahira	13.6	8.7	4.9 (2.2 to 7.3)	0.0001
Musandam	6.8	5.4	1.4 (-0.09 to 2.9)	0.35
Total	10.5	8.2	2.3 (1.6 to 2.8)	0.0001

See footnote to Table 1 for diagnostic criteria of the WHO and ADA. CI=confidence interval; *using McNemar's test.

all other regions had a higher prevalence of diabetes according to the WHO criteria compared to the ADA criteria. The difference ranged from -0.4% to 4.9%, with an overall significant difference of 2.3%.

Discussion

Studies of microvascular complications in NIDDM patients suggest that the onset of this condition occurs at least 4-7 years before clinical diagnosis.⁹ Evidence also shows that strict glycemic control prevents microvascular complications.¹⁰ This was one of the rationales behind the modifications of the diagnostic criteria by the ADA, which attempted to simplify the diagnostic test for early identification of individuals with undiagnosed diabetes.⁴ In addition, the new ADA criteria for the diagnosis of DM and IFG aim at an early identification of individuals at higher risk of microvascular complications during routine day-to-day clinical practice. Acknowledging that this method would lead to "slightly lower estimates of prevalence,"⁴ the ADA suggests that the "lost" cases would be more than compensated for by the increased use of a simpler fasting test.¹¹

Analyzing the impact of the new ADA criteria on the prevalence of DM and IGT/IFG in Oman shows that both conditions will be underestimated, the former by 2.2% and the latter by 4.8%. This would translate to around 14,000

fewer people with diabetes and more than twice that number fewer with impaired fasting glucose in Oman. These results are consistent with other studies, where application of the ADA criteria led to underestimation of DM and IGT by 7.1% and 17.5%, respectively.⁸

Similarly, seven out of eight regions had lower prevalence of diabetes and IGT when applying the ADA criteria. Wider differentials were seen in regions which were estimated to have higher prevalence of both conditions in the 1991 survey.

The implications of this disagreement are more profound at the individual level, since the status of a substantial number of individuals will be changed; those with diabetes becoming classified as normal or having IFG (15.3% and 14.5% of WHO diabetics, respectively), and those who were classified as normal by the WHO criteria ending up as diabetics or having IFG (0.5% and 3.1%, respectively).

Unlike an earlier study,⁷ this study does not show that the differences in diagnosis of diabetes by WHO and ADA criteria are related to gender, age and body mass index.

The application of the ADA criteria will result in a decrease in the prevalence of diabetes mellitus and impaired glucose tolerance in most regions of Oman. The decrease in prevalence seems to affect IGT more profoundly than diabetes mellitus. However, a more important implication is the reclassification of a substantial number of individuals from being diabetics to having IFG or even being reclassified as normal.

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