

**Prevalence of Diabetes Mellitus and Impaired Fasting Glucose in the  
Adult Population of Iran:**

*The National Survey of Risk Factors for Non-Communicable Diseases of Iran*

Alireza Esteghamati, MD<sup>a</sup>; Mohamad M. Gouya, MD, MPH<sup>b</sup>; Mehrshad Abbasi, MD<sup>a</sup>;  
Alireza Delavari, MD<sup>b</sup>; Siamak Alikhani, MD, MPH<sup>b</sup>; Farishid Alaedini, MD, PHD<sup>b</sup>;  
Afshin Safaie, DMSc, MPH<sup>b</sup>; Mehrdad Forouzanfar, MD, PHD<sup>cd</sup>; Edward W. Gregg, PHD<sup>e</sup>

<sup>a</sup>Endocrine Research Center, Valiasr Hospital, Tehran, Tehran, Iran

<sup>b</sup>Center for Disease Control, Tehran, Iran

<sup>c</sup> Endocrine Research Center, Shariati Hospital, Tehran, Iran

<sup>d</sup> Epidemiology and Biostatistics, Tehran University of Medical Sciences, Tehran, Iran

<sup>e</sup> Division of Diabetes Translation, Centers for Disease Control and Prevention, Atlanta, GA

Running title: Diabetes in Iran

*Correspondence:*

A.R. Esteghamati

Associate Professor of Internal Medicine and Dean of Faculty of Medicine

Tehran University

Esteghamati@sina.tums.ir

Received for publication 19 May 2007 and accepted in revised form 3 October 2007.

**Abstract**

Despite concerns of a diabetes epidemic in the Middle East, internationally published data on national estimates of prevalent type 2 diabetes in Iran do not exist. In this article we document a dramatically high prevalence of diabetes in Iran based on the results of the first Survey of Risk Factors of Non-Communicable Diseases (SURFNCD) of Iran, 2005. In this national cross-sectional survey recruiting 70,981 Iranian citizens aged 25 to 64 years, we found that 7.7% of adults aged 25-64, or 2 million adults, have diabetes, among whom half are undiagnosed. An additional 16.8%, or 4.4 million, of Iranian adults have impaired fasting glucose. This high prevalence of diabetes in working aged adults is an ominous sign for this developing nation. As the relatively young Iranian population ages in the future, and urbanization continues or accelerates, the prevalence of diabetes will likely escalate.

## Introduction:

The Middle East is expected to bear one of world's greatest increases in the absolute burden of diabetes in the coming decades. Most of this increase is anticipated to affect the economically productive 45 to 64 year old age segment, in contrast with most developed countries, where the increase in diabetic patients will occur in those  $\geq 65$  years old [1]. Although national estimates of the diabetes burden in Iran do not exist, the most recent study reported a high prevalence of diabetes in the highly urbanized population of Tehran, Iran's capital city [2]. Here we report the diabetes-related results of the national Survey of Risk Factors of Non-Communicable Diseases (SURFNCD) of Iran. As a population-based sample of over 89,000 Iranians, this study provides an opportunity to estimate the national prevalence and burden of IFG and diabetes. As such, it provides a valuable baseline for public health planning.

## Research Design and Methods:

The first Iran SURFNCD, a nationally representative cross-sectional health survey, was conducted in January and February, 2005 using guidelines of the stepwise approach to noncommunicable disease risk factor surveillance of WHO [3,4]. In brief, a multi-stage probability cluster sampling scheme was used to randomly sample 89400 adults aged 15 to 64 from the urban and rural noninstitutionalized population of all 28 provinces of Iran.

Participants were interviewed and examined to determine demographic characteristics and medical conditions, including a history of diabetes. Participants who reported a history of physician or health care professional -diagnosed diabetes are classified to have known diabetes (KDM). Subsequently, all participants aged 25-64 years (70,981 individuals) were asked to attend a health facility or laboratory for

collection of blood samples following a 12-hour fast. The departments of laboratory and medical diagnosis of each corresponding medical university in provinces selected the laboratories based on standard instructions. The laboratories measured FPG with coefficients of variation less than 3%. Out of all 89440 respondents, 18459 individuals were under 25 years and of the remaining 70,981 individuals 53,508(75.4%) participated in the biochemical examination. Blood specimens were collected and handled under standard conditions. After excluding 406 (0.7%) subjects who did not fast and another 871 (1.6%) with invalid blood samples, FPG was measured in 52,231 individuals. In those without KDM, FPG  $\geq 126$  mg/dl were regarded as newly diagnosed diabetes mellitus (NDM). Those without KDM having FPG levels  $\geq 100$  mg/dl (5.6 mmol/l) but  $<126$  mg/dl (7.0 mmol/l) were designated as having impaired fasting glucose (IFG) [5].

Data were analyzed considering the cluster and design effects using STATA version 8.0. To extrapolate the results to the Iranian adult population, data were weighted directly to Iran population aged  $\geq 25$  and  $<65$  years, estimated from the 1996 national census, to match the age (10-year strata), sex, and area of residence (rural/urban).

## Results:

Total prevalence of diabetes was 7.7% (95% confidence interval [CI]: 7.5-7.9%), equivalent to 2.0 million cases when extrapolated to the Iran population aged 25-64 years (Table). Prevalence of diabetes was about a third higher in urban areas (8.6%) than in rural areas (5.7%). About a half of these cases (1.0 million) were previously undiagnosed. Moreover, 16.8% (CI: 16.4-17.2%), comprising 4.4 million people, had IFG. The peak prevalence was observed among persons aged 55-64 (16.8%), whereas

the greatest total numbers (0.6 million) of diabetic persons was among the 45-54 years age group.

Age-specific prevalence of diabetes was 3.0%, 5.8%, 10.8%, and 14.0% in men and 3.0%, 7.0%, 14.0%, and 19.4% in women aged 25-34, 35-44, 45-54, and 55-64, respectively. This age-related increase in diabetes prevalence was significantly greater among women than men ( $p < 0.003$  for sex-age interaction). Age-specific prevalence of IFG was 13.4%, 17.3%, 19.9%, and 21.9% in men and 10.1%, 16.4%, 21.8%, and 26.0% in women aged 25-34, 35-44, 45-54, and 55-64, respectively; the interaction of sex and age on prevalent IFG was significant ( $P < 0.0001$ ).

### **Conclusions:**

In this first nationally representative report of the burden of diabetes in Iran, we found a high prevalence of diabetes and IFG (8% and 17% respectively), and a large proportion (50%) of undiagnosed diabetes. These estimates would be even greater if an oral glucose tolerance test were used in addition to fasting glucose. An additional concern highlighted by our study is the large burden of diabetes among the middle-aged population. Given the increasing life expectancy of Iranians, this observation suggests that the total number of persons with diabetes is likely to be a particular challenge to the Iranian health care system in coming decades.

Prevalence estimates of this study are comparable with those of the United States (9.6% overall; 10.5% of men and 8.8% of women) and Australia (7.4%; 8.0% and 6.4% of men and women) [6-8], as well as with reports of countries in the Middle East. In a previous study, Iranians aged 40-59 years residing in Bahrain, a neighboring country, had a diabetes prevalence of an astounding 23%. Interestingly, this was considerably lower than other ethnicities (48% in Sunni Arabs and 31% in Jafari Arabs) but is nevertheless much higher than what was observed in our study [9]. The overall prevalence of diabetes in Oman, another neighboring country, was reported as 11.6% in 2000 [10]. That study also noted much higher diabetes prevalence in the urban population (17.7%) compared to the rural population (10.5%). In light of the strong association between urbanization and diabetes prevalence in our study as well as in the study in Oman, and given the current 2.6% growth rate in the population of urban areas in Iran, compared to 1.4% population growth rate [11], diabetes may be expected to increase in Iran.

Female sex was associated with a higher prevalence of diabetes particularly among older persons, a finding that contrasts with data of the United States, and Australia. Consistent with data from the United States, males sex was associated with increased prevalence of IFG [12].

**References:**

- [1] Wild S, Roglic G, Green A, Sicree R, King H: Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes Care* 27:1047–1053, 2004
- [2] Azizi F, Rahmani M, Emami H, Mirmiran P, Hajipour R, Madjid M, Ghanbili J, Ghanbarian A, Mehrabi Y, Saadat N, Salehi P, Mortazavi N, Heydarian P, Sarbazi N, Allahverdian S, Saadati N, Ainy E, Moeini S. Cardiovascular risk factors in an Iranian urban population: Tehran lipid and glucose study (phase 1). *Soz Praventivmed.* 47(6):408-26, 2002
- [3] STEPwise approach to surveillance (STEPS) available online,2004.website at <http://www.who.int/chp/steps/en/> .Accessed 16 March 2007
- [4] Delavari AR, Alikhani S, Alaedini F: A National Profile of Non-Communicable Disease Risk Factors in the I.R.of Iran. Tehran , Iran Center for Disease Control, Ministry of Health&Medical Education, 2005
- [5] American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care* 28:S37–S42, 2005
- [6] Centers for Disease Control and Prevention. National diabetes fact sheet: general information and national estimates on diabetes in the United States, 2005. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2005.
- [7] Geiss LS, Pan L, Cadwell B, Gregg EW, Benjamin SM, Engelgau MM. Changes in incidence of diabetes in U.S. Adults, 1997-2003. *Am J Prev Med* 30(5):371-7, 2006
- [8] Dunstan DW, Zimmet PZ, Welborn TA, De Courten MP, Cameron AJ, Sicree RA, Dwyer T, Colagiuri S, Jolley D, Knuiaman M, Atkins R, Shaw JE: The rising prevalence of diabetes and impaired glucose tolerance: the Australian Diabetes, Obesity and Lifestyle study. *Diabetes Care* 25:829–834, 2002
- [9] Al-Mahroos F, Mckeigue PM: High Prevalence of Diabetes in Bahrainis: Associations with ethnicity and raised plasma cholesterol. *Diabetes Care* 21( 6):936-42, 1998
- [10] Al-Moosa S, Allin S, Jemiai N, Al-Lawati J, Mossialos E: Diabetes and urbanization in the Omani population: an analysis of national survey data. *Popul Health Metr* 4:5, 2006
- [11] UNICEF- At a glance –Statistics [web page online]. Available from [http://www.unicef.org/infobycountry/iran\\_statistics.html](http://www.unicef.org/infobycountry/iran_statistics.html). Accessed May 2007
- [12] Cowie CC, Rust KF, Byrd-Holt DD, Eberhardt MS, Flegal KM, Engelgau MM, Saydah SH, Williams DE, Geiss LS, Gregg EW: Prevalence of Diabetes and Impaired Fasting Glucose in Adults in the U.S. Population: National Health and Nutrition Examination Survey 1999–2002. *Diabetes Care* 29 (6) : 1263-1268,2006

**Table 1\_ Estimates of prevalence and burden of newly diagnosed and known diabetes and IFG in the Iranian 25- to 64-year-old population**

	<i>Impaired Fasting Glucose<sup>a</sup></i>		<i>Known DM</i>		<i>New DM<sup>a</sup></i>		<i>New and Known DM<sup>a</sup></i>	
	<i>Burden</i>	<i>Prevalence % (CL)</i>	<i>Burden</i>	<i>Prevalence % (CL)</i>	<i>Burden</i>	<i>Prevalence % (CL)</i>	<i>Burden</i>	<i>Prevalence % (CL)</i>
<b>Age<sup>b</sup></b>								
25-34	1,217,452	11.9 (11.2-12.5)	102,657	1.0 (0.8-1.1)	201,649	2.0 (1.7-2.2)	311,983	3.0 (2.7-3.4)
35-44	1,336,701	17.3 (16.6-18.1)	248,560	3.2 (3.0-3.5)	269,739	3.5 (3.2-3.8)	519,117	6.8 (6.3-7.3)
45-54	1,070,898	21.4 (20.6-22.2)	368,966	7.4 (7.0-7.8)	294,260	5.9 (5.5-6.3)	629,209	12.9 (12.3-13.5)
55-64	791,266	24.3 (23.4-25.1)	329,850	10.1 (9.7-10.6)	235,564	7.2 (6.7-7.7)	531,580	16.8 (16.1-17.4)
<b>Sex<sup>c</sup></b>								
Men	2,321,870	17.4 (16.8-17.9)	428,275	3.2 (3.0-3.4)	518,094	3.9 (3.6-4.1)	933,799	7.1 (6.7-7.4)
Women	2,094,447	16.3 (15.8-16.8)	621,759	4.8 (4.6-5.0)	483,118	3.8 (3.5-4.0)	1,058,090	8.3 (8.0-8.7)
<b>Residential area<sup>d</sup></b>								
Rural	1,143,041	14.6 (14.0-15.1)	217,785	2.8 (2.6-3.0)	237,312	3.0 (2.8-3.3)	442,107	5.7 (5.3-6.0)
Urban	3,273,276	17.8 (17.3-18.3)	832,249	4.5 (4.3-4.7)	763,900	4.2 (3.9-4.4)	1,549,782	8.6 (8.3-8.9)
<b>Total national estimation<sup>e</sup></b>	4,416,317	16.8 (16.4-17.2)	1,050,033	4.0 (3.9-4.1)	1,001,212	3.8 (3.6-4.0)	1,991,889	7.7 (7.5-7.9)

**DM, diabetes mellitus; CL, 95% confidence limits**

<sup>a</sup> Based on participants' laboratory results

<sup>b</sup> Standardized for sex and residential area

<sup>c</sup> Standardized for age and residential area

<sup>d</sup> Adjusted for age and sex

<sup>e</sup> Weighted and standardized for age, sex, and residential area on the basis of 2004 Iran population