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Trends in the prevalence of diabetes and impaired fasting glucose in association with obesity in Iran: 2005–2011

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ABSTRACT

Aims: To estimate the prevalence and trends of diabetes mellitus (DM) and impaired fasting glucose (IFG), 2005–2011, and to determine the contribution of obesity to DM prevalence.

Patients and methods: Data from Surveillance of Risk Factors of Non-communicable Diseases (SuRFNCD) conducted in 2005, 2007, and 2011 were gathered. DM was defined as presence of self-reported previous diagnosis or a fasting plasma glucose (FPG) $\geq$ 7 mmol/L. IFG was diagnosed with FPG levels between 5.6 and 6.9 mmol/L. Prevalence rates for 2011 and trends for 2005–2011 were determined by extrapolating survey results to Iran's adult population. Population attributable fraction (PAF) of obesity was also calculated.

Results: In 2011, IFG and total DM prevalence rates were 14.60% (95%CI: 12.41–16.78) and 11.37% (95%CI: 9.86–12.89) among 25–70 years, respectively. DM was more common in older age ($p < 0.0001$), in women ($p = 0.0216$), and in urban-dwellers ($p = 0.0001$).

In 2005–2011, trend analysis revealed a 35.1% increase in DM prevalence (OR: 1.04, 95%CI: 1.01–1.07, $p = 0.011$); albeit, IFG prevalence remained relatively unchanged (OR: 0.98, 95%CI: 0.95–1.00, $p = 0.167$). In this period, DM awareness improved; undiagnosed DM prevalence decreased from 45.7% to 24.7% ($p < 0.001$). PAF analysis demonstrated that 33.78%, 10.25%, and 30.56% of the prevalent DM can be attributed to overweight (BMI $\geq$ 25 kg/m^2), general obesity (BMI $\geq$ 30 kg/m^2), and central obesity (waist circumference $\geq$ 90 cm), respectively. Additionally, the DM increase rate in 2005–2011, was 20 times higher in morbidly obese compared with lean individuals.

Conclusion: More than four million Iranian adults have DM which has increased by 35% over the past seven years, owing in large part, to expanding obesity epidemic.

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1. Introduction

Diabetes mellitus (DM) is a global public health concern that is reaching staggering proportions. Based on a recent report by the International Diabetes Federation (IDF), DM affected 366 million people in 2011, and this number is expected to rise to 552 million by 2030 [1]. The IDF Diabetes Atlas also stated that the Middle East and North Africa (MENA) region currently has the highest regional prevalence of DM, and by 2030 it is expected to have the second largest proportional increase after Africa [2]. In accordance with this data, we have reported a marked increase in the national prevalence of DM from 7.7% to 8.7% over a three year period (2005–2007) [3]. Upward trends have also been reported in other developing and developed countries. Between 1993 and 2003, the DM prevalence in China almost tripled (1.9% vs. 5.6%) [4].

In the UK, the DM prevalence rose from 2.8% to 4.3% over a 10-year period (1996–2005) [5]. Similarly, between 1995 and 2005, the proportion of Canadian adults with DM increased by 69% (5.2% vs. 8.8%) [6].

In 2007, DM accounted for $174 billion of health spending in the US [7]. In Iran, the annual direct costs of DM were estimated to be $590 million in 2009 [8]. Indeed, the burden of DM is not limited to direct health care expenditure; indirect costs caused by loss of productivity and premature mortality in adults of working-age also contribute to this global calamity, which is reaching catastrophic proportions [9]. In addition to the health resources allocated for DM, an abundance of resources is directed toward the management of impaired fasting glucose (IFG), a pre-diabetes state. Subjects with IFG, compared to healthy individuals, have higher medical costs, which are largely due to cardiovascular complications [10]. In addition, it has been estimated that as many as 70% of individuals diagnosed with IFG, will eventually progress to DM [11]. Physical inactivity, rapid economic transition and urbanization, excessive caloric intake and more importantly, obesity, are closely associated with DM. With an accelerated increase in the obesity prevalence in the past 20 years, it is postulated that developing countries will soon face an upsurge in DM [12]. The prevalence of obesity in Iran has increased from 13.6% in 1999 to 22.3% in 2007 [13]. Obesity, either in general or central forms, is believed to be a substantial risk factor for the development of type 2 DM [14]. One unit increase in body mass index (BMI) has been shown to raise the incidence of DM by 25% [15].

To provide a better understanding of the prevalence of non-communicable diseases and their associated risk factors, the Surveillance of Risk Factors of Non-communicable Diseases (SuRFNCD) was initiated in Iran, in 2005. In the present study, we report on the nation-wide prevalence of IFG and DM, derived from Iran's 2011 SuRFNCD. Moreover, we delve into secular trends of DM observed over the 2005–2011 period. Finally, since obesity confers substantial risk for the development of DM, the contributions of; overweight, general, and central obesity, to the prevalence of DM among Iranian adults are investigated.

2. Methods

2.1. SuRFNCD-2011

This randomized multistage cluster sampling scheme was designed to select a representative sample of non-hospitalized and non-institutionalized Iranian individuals, 6–70 years-of-age. Furthermore, nomadic tribes (population according to 2011 national census = 56,225), who live in settlements that are not covered by the Iranian postal service, were not included. By employing a four stage sampling scheme, between May 22nd and June 20th 2011, a total of 11,867 individuals were surveyed.

At the first stage of sampling, individual counties, or a group of neighboring counties were designated as primary sampling units (PSUs). Fifty PSUs were then selected by employing the probability proportionate to size (PPS) random sampling method. In each PSU, 12 areas were selected as secondary sampling units (SSUs), in a manner similar to the previous step. In the third stage, 20 postal addresses (10-digit postal codes) within each SSU, from a framework provided by the Iran's postal service, were randomly selected. Each address was contacted and the inhabitants were registered. We hypothesized that conventional Kish tables provided by the World Health Organizations (WHO) would result in under sampling of adults $\geq$55 years old. Therefore, two independent sets of Kish tables for persons $<$55 and $\geq$55 years were developed. One individual was chosen from each Kish table and they were visited at their household. After three attempts, if a sampling individual was not available or refused to participate, the label 'non-response' was applied. The cluster sampling was conducted under the direction of Iran's Center for Disease Control (CDC). The final stage was carried out by trained interviewers and was supervised by 43 medical universities across the country.

At the beginning of each interview, a consent form was read by the interviewer and acceptance or refusal to participate was formally recorded. All procedures described here were conducted in accordance with the guidelines and standards laid down in the current revision of the Declaration of Helsinki. The CDC Board of Ethics also approved the study protocol. A total of 5279 adults aged 25–70, and 4759 adults aged 25–64 years, with valid responses to the DM questions and available laboratory measurements were included from the survey.

2.2. SuRFNCD-2005 and 2007

For the analysis of DM secular trends, and trends according to general and central obesity, the data from the SuRFNCD-2005 [16] and SurFNCD-2007 [3] were collected. In the SuRFNCD-2005 and -2007, 51,903 and 3342 Iranian adults aged 25–64 had questionnaires and laboratory evaluations available and therefore they were included. Despite differences in design, sampling protocols, and sample sizes, all three SuRFNCD surveys are representative of the Iranian population. The methodology employed for physical examination and laboratory measurements were similar in all three rounds and are described below.