Original Article

Trend analysis of the rate of mortality due to diabetes mellitus in Iran during the period of 2003-2010: A join point regression analysis

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Abstract

Background: Determining the mortality rate of diseases in a community is one of the main components in health care planning of that community. This study used a join point regression model to determine the trend of mortality due to diabetes mellitus (DM) in Iran.

Materials and Methods: The data on the rate of mortality due to DM were obtained from the reports of the Iranian Ministry of Health. The variation in the trend of mortality due to DM over the past eight years was analyzed using the join point regression model. For the evaluation of the regression parameters, the permutation test and least square method were applied. Data analysis was performed using the JOINPOINT statistical software.

Results: The number of deaths due to DM has increased from 3047 cases per 100,000 people in 2003 to 5838 cases per 100,000 in 2010. A variation point was observed in 2007 with a P-value of 0.06 and 4500 permutations. The annual percentage change (APC) of the rate of mortality due to DM for the first period (2003-2007) was 6.6% with a confidence interval of -3-17.2 and for the second period (2007-2010) was 1.8% with a confidence interval of -12.4-18.2. APC was 4.6% in men with the confidence interval of 2.4-6.9 and 4.5% in women with the confidence interval of 2-7.

Conclusions: The rate of mortality due to DM in Iran has increased during this 8-year period. The rate of mortality due to DM increased with a steep slope from 2003 to 2007 and with a gentle slope from 2007 to 2010.

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Introduction

Diabetes mellitus (DM) is the most common manifestation of disease in the world, responsible for 4 million deaths per year until 1985. Today, 30 million people are suffering from DM around the world. It is estimated that this figure will rise to 230 million individuals by 2008 (1). The number of people with DM has significantly increased during the last 20 years (2).

Due to the rising trend of DM in the world, it has been announced as a hidden epidemic by the World Health Organization (WHO). The global prevalence of DM in 2010 among adults (20-79 years of age), was 4.6%, equivalent to 285 million people. This rate will increase to 7.7%, equivalent to 439 million people by 2030. An increase of 69% in developing countries and 20% in developed countries in this rate will be observed from 2010 to 2030 (1). Unfortunately, this increase is significant in developing countries, including our country (3).

Determination of the incidence of diseases in a community is one of the main components of health care planning of that community. Knowledge of the pattern of change in the incidence of diseases in a country can be of

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great importance for the health care planning of that country. Public health agencies believe that monitoring disease incidence, mortality, and social, behavioral, and health risk factors may contribute to adverse health effects. Assessment of the trends in disease incidence or prevalence provide valuable information for needs assessment, designing, and reviewing of the plans and development indicators of any country (4).

In studying data on subjects such as mortality and cancer incidence, one of the common concerns is the detection of a variation in the trend. In situations in which we are faced with a variation in risk factors, screening programs or other interventions are required. Sudden changes in population structure, such as emigration, may impact the incidence or prevalence of disease. It is therefore important to be able to detect when significant changes occur. Different statistical techniques such as regression and time series are used to examine trends over time. Simple linear regression, due to its consideration of a general linear relationship between amount or frequency and one calendar year, cannot display changes in trend over time. Segmental analysis is able to detect these points and determine the trend between these points (5). In this study, a joinpoint regression model was used to determine the trend of mortality caused by DM in Iran.

Materials and Methods

In Iran, the Ministry of Health and Medical Education in partnership with the Local Register Office have taken an important step in determining the pattern of mortality in the country and monitoring its trend through implementing programs to record the cause of death and personal characteristics of the deceased. The result of this program will be the use of its findings in the formulation, designing, and implementation of intervention programs and evaluation of public health programs (6). A national registration system for vital events has been implemented in 29 provinces. Based on data collected through the registration and classification of causes of death, a report entitled the face of death of the country has been prepared and published by the network management center. In this study, the rate of mortality due to DM in 29 provinces published from 2003 to 2010 was applied (7).

Joinpoint regression is also called piecewise regression, two-state or multistate continuous regression, the least square two-step, and Broken line regression.

Joinpoint regression is one method of regression analysis in which the main and independent variable is divided. For each interval, a separate regression line is fitted and the boundary between parts is called breakpoints. To express the continuous breakpoints on mortality and the incidence of disease, joinpoints regression was used. Breakpoints are also called joinpoints, difference point, and nodes.

The joinpoint regression model for the observations $(x_1, y_1), \dots (x_N, y_N)$ where $x_1 < \dots < x_N$ is time and y_i response variables, for example, the standardized annual rate. may be written as

$$E(y_i|x_i) = \beta_0 + \beta_1 x_i + \gamma_1 (x_i - \tau_1)^+ + \dots + \gamma_n (x_i - \tau_n)^+$$

Where the $\tau_k's$ are the unknown joinpoints and $(x_i - \tau_k)^+ = (x_i - \tau_k)$ if $(x_i - \tau_k) \leq 0$and 0 otherwise.

Where β_0, β_1, $y_1, \dots$, y_n are regression coefficients and τ_k (k = 1,2,..,n; n < N) is the K^{th} breakpoint (8).

In this study, the response variable was the rate of mortality due to DM and the independent variable was the studied years (2003-2010).

For joinpoint regression model, the least squares method [Hudson (8), Lerman (9), and permutation test (10)], and for data analysis, JOINPOINT software (version 4.1.1.1) were used. Joinpoint is statistical software for the analysis of trends using joinpoint models, that is, models like the figure 1 where several different lines are connected together at the "joinpoints". Cancer trends reported in NCI

publications are calculated using the Joinpoint Regression Program to analyze rates calculated by the SEER*StatExternal Website Policy software. The number and location of points of variation in the trend of mortality due to DM were estimated and the regression parameters of jointpoint were estimated using the Lerman, Hudson, and permutation test techniques.

Results

Between the years 2003 to 2010, 38,394 deaths have occurred due to DM in Iran.

Fitting of the annual death rate due to DM with a variation point showed that only one significant breakpoint with a P-value of 0.07 and 4500 repeated permutation test had existed in 2007 with a confidence interval.

Thus, the response function of the average joinpoint regression for mortality due to DM was equal to the following amount:

$E(y/x) = -86.58 + 0.06x - 0.05 (x - 1386)^{+}$

The annual percentage change (APC) of DM mortality rates for the first segment (2003-2007) was 6.6% with the confidence interval of -3-17.2 and for the second segment (2007-2010) was 1.8% with the confidence interval of -12.4-18.2. The average APC (AAPC) for the eight-year period was 4.5%. The number of deaths due to DM has increased from 3047 cases per 100,000 people in 2003 to 5838 cases per 100,000 people in 2010 (more than 1.5-fold increase). The lowest and highest mortality rates due to DM were 3.6 and 9.82 per 100,000 people in 2003 and 2010, respectively (Figure 1).

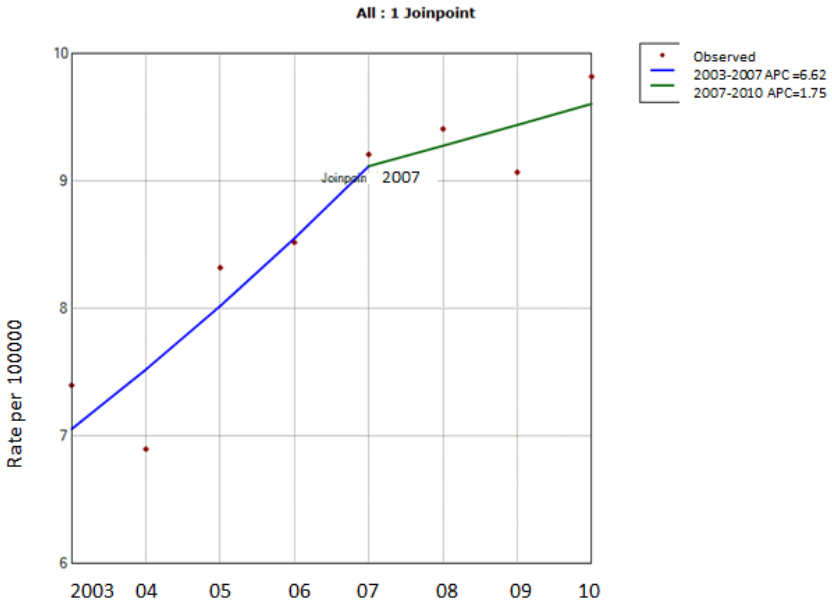

Figure 1: The rate of mortality due to diabetes in Iran (2003-2010)

The data on the annual mortality rate due to DM for men and women were fitted separately.

Therefore, the response function of the average joinpoint regression for mortality due to DM in men was equal to the following amount:

$$E(y/x) = -60.77 + 0.04x$$

The annual rate of mortality due to DM among men was studied. The results showed no variation point during this time period for men (P = 0.46, and 4500 permutations).

The APC of mortality in men due to DM during 2003 to 2010 was equal to 4.6% and with a confidence interval of 2.4 to 6.9. The rate of mortality among men due to DM increased from 7.1 per 100,000 people in 2003 to 8.73 per 100,000 people in 2010. The lowest and highest rate of mortality due to DM

in men was observed in 2004 (6.2 per 100,000 inhabitants) and 2010, respectively.

The annual rate of mortality due to DM in women was also studied. The response function of the average joinpoint regression for the rate of mortality due to DM among women was equal to the following amount:

$$E(y/x) = -58.53 + 0.04x$$

The results showed no variation point in this time interval (P= 0.18 and 4500 permutations).

The APC of mortality due to DM among women was equal to 5.4% with a confidence interval of 2-7. Moreover, the AAPC for this eight-year period was 4.5%. The rate of mortality due to DM among women increased from 8.46 per 100,000 people in 2003 to 10.91 per 100,000 people in 2010. The lowest and highest rate of mortality in women was observed in 2004 and 2010, respectively (Figure 2).

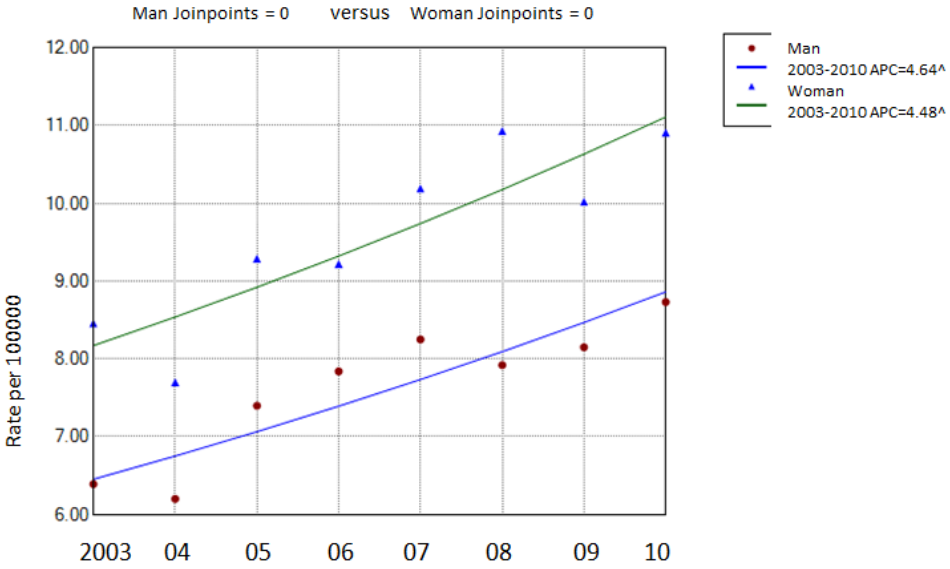

Figure 2: The rate of mortality due to diabetes among men and women (2003-2010)

Discussion

The results showed that the rate of mortality due to DM has increased an average of 4.5% for the total population, 4.6% for men and 4.5% for women, each year from 2003 to 2010. The rate of mortality due to DM has increased from 2003 to 2007 with a steep slope and from 2007 to 2010 with a gentle slope. The increase in mortality rate from 2003 to 2007 may be due to the increased ability to determine the cause of death. In Iran, there was a joinpoint in 2006 is related to screening programs (11) which was started in 2004 in the country (12) According to the results, the program in 2006, their impact on mortality caused by diabetes. The increase rate of mortality due to DM may be attributed to the increased and prolonged time of exposure to risk factors and the change in lifestyle.

Analysis of the causes of death in the United States of America showed that the rate of mortality due to DM has increased 45% since 1987 (11). A study of the Canadian population (1995-2005) showed that an increase in self-reported diabetes led to the increased prevalence of diabetes and reduced diabetes-related mortality (12). The National Institute of Diabetes in Denmark reported that from 1995 to 2006, the rate of mortality in the DM population has decreased from 4% to 2% per year, compared to the non-diabetic population (13). A study in Italy showed that the prevalence of DM had not changed from 2000 to 2007, but the rate of deaths due to DM had declined 3% per year (14).

In more advanced and higher-income countries, the dominant causes of death are non-communicable diseases (15). DM is the fourth leading cause of death in developing

countries, sixth in middle-income countries, and the ninth in developing countries (16). Furthermore, a previous study has suggested that the effect of increasing urbanization and a sedentary lifestyle in society causes an increase in the prevalence of DM (1).

Conclusion

Special attention to increasing public awareness to identify risk factors and to modify them, and implementing appropriate changes in habits and lifestyle of the population will decrease the prevalence of risk factors in the population. Moreover, those at risk of developing diabetes due to the existence of risk factors can be identified through screening procedures and their risk factors can be eliminated or reduced.

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