Elmer Press

Original Article

J Endocrinol Metab. 2015;5(6):328-332

Epidemiological Trends in the Morbidity and Mortality Among Adults With Type 2 Diabetes Mellitus in South Korea Between 2009 and 2012

Young-Han Kwon[a], Hyeong-Ae Bang[b], Won-Hak Kim[c], Myeong-Jin Lee[d], Won-Chang Lee[e, f]

Abstract

Background: The objective of this study was to study the epidemiological trends in morbidity rate (MbR) and mortality rate (MR) of type 2 diabetes mellitus (T2DM) by International Classification of Diseases (Codes of ICD: E11.0-E11.9) among adults in Korea (Republic of) between 2009 and 2012.

Methods: Raw data analyzed in this study were obtained from the website of "the Statistics Data on the Morbidity and Mortality of Diabetes" of the Annual Report of the Korea Center for Disease Control and Prevention (KCDC) and the Korea Statistics Promotion Institute (KSPI) between 2009 and 2012.

Results: There were a total of 5,975 nationwide morbidity cases (MCs) with respect to T2DM, with an MbR of 10.0% in 2009, while there were a total of 4,608 MCs with an MbR of 9.9% in 2012; the MbR of T2DM decreased slightly from 2009 to 2012. Moreover, there were a total of 6,293 nationwide case-fatalities (CFs) with an MR of 20.3 per 100,000 populations in 2009, while there were a total of 8,132 CFs with an MR of 24.5 in 2012; the MR of T2DM increased ($P < 0.01$). The MbRs (%) of T2DM in both males and females were not changed significantly between 2009 and 2012, while the MR in both males and females had significantly increased in T2DM from 2009 to 2012 ($P < 0.01$). However, in the 60 - 69 years old age group, the MbR of 2012 was significantly decreased than in 2009 ($P < 0.01$). Trends in CF (%) and MR (100,000 populations) of T2DM were compared with respect to the 10 key classifications of ICD (E11.0-E11.9) between 2009 and 2012 as follows: T2DM with coma, renal, peripheral circulatory and multiple complications tended to increase in 2012 than in 2009, while T2DM with ketoacidosis, other specified, and unspecified complications were decreased, respectively.

Conclusion: To counter the increasing morbidity of T2DM and its related mortality in Korea, multidirectional efforts including lifestyle modification should be mandatory features of future public health policy.

Keywords: Epidemiology; T2DM; Morbidity and mortality rate; Korea; ICD

Introduction

Diabetes is a major lifestyle disorder, the morbidity and mortality of which is an increasing global public health problem. In 2014, 9% of adults 18 years and older had diabetes. In 2012, diabetes was the direct cause of 1.5 million deaths. More than 80% of diabetes deaths occur in low- and middle-income countries [1]. The increased morbidity is likely attributable to rapid economic development, improved living standards, aging, urbanization, and an increasing prevalence of obesity and physical inactivity [1-3]. Especially, type 2 diabetes mellitus (T2DM: non-insulin-dependent) of diabetes and its complications have become a major cause of morbidity and mortality in Korea [3-5]. In Korea, the T2DM-related morbidity rate (MbR) has tended to increase from 8.9% of the population in 2001 to 9.9% in 2012 [4]. In addition, diabetes is still the fifth leading cause of death in Korea in the last decade [3, 5, 6]. Moreover, T2DM complications such as with codes from E11.0 to E11.9 by the International Classification of Diseases (ICD-10) are associated with increased medical care and reduced life expectancy [7].

In the present, a limitation of the study is that we investigated epidemiological trends in the mortality of T2DM among adults by the ICD-10 (WHO) in Korea between 2009 and 2012, in order to stimulate future strategies for improving public health epidemiology.

Methods

Data extraction

In order to analyze epidemic trends in the morbidity and mor-

Manuscript accepted for publication October 27, 2015

[a]Department of Internal Medicine, Aeromedical Center, Korean Air, Seoul, Korea
[b]The Korea Public Health Association, Korea
[c]Department of Nephrology, Asan Medical Center, Ulsan University, Seoul, Korea
[d]Public Health in Department of Nutritional Sciences, Otemae College of Nutrition, Osaka, Japan
[e]Public Health in College of Veterinary Medicine, Konkuk University, Seoul, Korea
[f]Corresponding Author: Won-Chang Lee, College of Veterinary Medicine, Konkuk University, Seoul 05029, Korea. Email: lwcdvm@gmail.com

doi: http://dx.doi.org/10.14740/jem322e

Table 1. Trends in the Morbidity Rate (%) of Type 2 Diabetes Mellitus Among Adults in Korea Between 2009 and 2012

Item	2009		2012	
	MC (%)	MbR (95% CI)	MC (%)	MbR (95% CI)
Nationwide	5,975	10.0 (9.0 - 11.0)	4,608	9.9 (8.7 - 11.1)
Gender				
Male	2,578 (43.1)	10.9 (9.5 - 12.3)	1,935 (42.0)	10.7 (9.1 - 12.3)
Female	3,397 (56.9)**	9.2 (8.0 - 10.4)	2,673 (58.0)**	9.1 (7.7 - 10.5)
Total	5,975		4,608	
Age-specific				
30 - 39	1,337 (22.4)	2.5 (1.5 - 3.5)*	905 (19.6)	1.9 (0.9 - 2.9)
40 - 49	1,423 (23.8)	5.8 (4.4 - 7.2)*	915 (19.9)	5.0 (3.2 - 6.8)
50 - 59	1,183 (19.8)	12.3 (10.1 - 14.5)	1,023 (22.2)	12.6 (10.1 - 15.2)
60 - 69	1,126 (18.9)	22.0 (19.3 - 24.7)**	943 (20.5)	20.3 (17.6 - 23.0)
> 70	906 (15.1)	21.8 (18.5 - 25.1)	822 (17.8)	22.0 (18.7 - 25.3)
Total	5,975		4,608	

MC: morbidity case; MbR: morbidity rate in percent populations; 95% CI: confident interval of 95%. Statistically significant levels set at *P < 0.05 and **P < 0.01.

tality (over the age of 30 whose death certificates) of T2DM among adults in Korea between the years of 2009 and 2012, we used raw data of T2DM obtained from the Korea Health Statistics: Korean National Health and Nutritional Examination Survey (KNHAN-IV, 2009 and KNHAN-V, 2012) by the Korea Center for Disease Control and Prevention (KCDC) [4], and Korea Statistics Promotion Institute (KSPI) (2009 - 2012): Diabetes. Annual Statistics Report on the Cause of Death, Statistic Korea Promotion Institute (KSPI) between 2009 and 2012 [5]. The cases of T2DM in KSPI were classified according to the ICD-10 (WHO). The code used for E11.0-E11.9: T2DM is as follows: E11.0: with coma, E11.1: with ketoacidosis, E11.2: with renal complications, E11.3: with ophthalmic complications, E11.4: with neurological complications, E11.5: with peripheral circulatory complications, E11.6: with other specified complications, E11.7: with multiple Complications, E11.8: with unspecified complications and E11.9: without complications, respectively [7].

Statistical analysis

In this study, the case-fatalities (CFs) in percentage (%), and the MR per 100,000 populations were estimated using the cri-

Table 2. Trends in the Mortality Rate of Type 2 Diabetes Mellitus Among Adults in Korea Between 2009 and 2012

Item	2009		2012	
	CF (%)	MR (95% CI)	CF (%)	MR (95% CI)
Nationwide	6,293	20.3 (19.8 - 20.8)	8,132	24.5 (24.0 - 25.0)**
Gender				
Male	3,224 (51.2)*	21.3 (20.6 - 22.1)	4,159 (51.1)*	25.6 (25.5 - 25.8)**
Female	3,069 (48.8)	19.2 (18.5 - 19.9)	3,973 (48.9)	23.4 (23.0 - 23.7)**
Total	6,293		8,132	
Age-specific				
30 - 39	50 (0.8)	0.6 (0.4 - 0.8)	49 (0.6)	0.8 (0.6 - 1.0)
40 - 49	249 (4.0)	2.8 (2.5 - 3.2)	213 (2.6)	2.4 (2.1 - 2.7)
50 - 59	670 (10.6)	10.3 (9.3 - 11.3)	715 (8.8)	10.1 (9.4 - 10.8)
60 - 69	1,255 (19.9)	31.0 (29.3 - 32.7)	1,300 (16.0)	31.0 (29.3 - 32.1)
> 70	4,069 (64.6)**	121.3(120.3 - 122.3)	5,855 (72.0)**	163.0 (159.1 - 166.9)**
Total	6,293		8,132	

CFs: case-fatalities; MR: mortality rate per 100,000 populations; 95% CI: confident interval of 95%. Statistically significant levels set at *P < 0.05 and **P < 0.01.

Table 3. Trends in Mortality Rate Among Adults With Type 2 Diabetes Mellitus by the ICD in Korea Between 2009 and 2012

Codes by ICD	2009		2012	
	CF (%)	MR (95% CI)	CF (%)	MR (95% CI)
E11.0: Coma	113 (1.8)	0.4 (0.3 - 0.5)	174 (2.1)	0.5 (0.4 - 0.6)*
E11.1: Ketoacidosis	92 (1.5)	0.3 (0.2 - 0.4)	81 (1.0)	0.2 (0.1 - 0.3)
E11.2: Renal com.	756 (12.0)	2.4 (2.3 - 2.5)	1182 (14.5)	3.6 (3.4 - 3.8)**
E11.3: Ophthalmic com.	4 (0.1)	-	12 (0.1)	-
E11.4: Neurological	221 (3.5)	0.7 (0.6 - 0.8)	197 (2.4)	0.6 (0.5 - 0.7)
E11.5: Peripheral com.	415 (6.6)	1.3 (1.2 - 1.4)	2,096 (25.8)	6.3 (6.1 - 6.6)**
E11.6: Other specified	592 (9.4)	1.9 (1.8 - 2.1)**	90 (1.1)	0.3 (0.2 - 0.4)
E11.7: Multiple com.	1,795 (28.5)	5.8 (5.5 - 6.1)	2,514 (30.9)	7.6 (7.3 - 7.9)**
E11.8: Unspecified	851 (13.5)	2.7 (2.5 - 2.9)**	535 (6.6)	1.6 (1.5 - 1.7)
E11.9: Without com.	1,454 (23.1)	4.7 (4.5 - 4.9)**	1,251 (15.4)	3.8 (3.6 - 4.0)
Total	6,293	20.3 (19.8 - 20.8)	8,132	24.5 (24.0 - 25.0)**

Footnotes are in Table 2. com.: complication.

teria established by the WHO, and the upper and lower limits of 95% confidence interval (CI) were calculated. Statistically significant differences between the epidemiological aspects and risk factors were determined using the Chi-square test or paired *t*-test, and the data analyses were performed using the Excel 2007 statistical software (Microsoft Corp., Redmond, WA, USA). Statistically significant levels were at *P < 0.05 and **P < 0.01.

Results

Trends in morbidity cases (MCs) and MbR of T2DM in Korea between 2009 and 2012 were compared by nationwide, gender and age groups as shown in Table 1. There were a total of 5,975 MCs with T2DM with an MbR of 10% in 2009, while there were a total of 4,608 MCs with an MbR of 9.9% in 2012; the MbR of T2DM decreased a little. In the cases by gender, the MC (%) of T2DM among men was much lower than among women in both 2009 (43.1% vs. 56.9%) and 2012 (42.0% vs. 58.0%) respectively (P < 0.01). However, in the cases by gender, the MbRs (%) of T2DM in both males and females were not changed significant between 2009 and 2012. On the other hand, the distributions of the MbR (%) of T2DM by age groups in 2009 were as follows: in the age groups of 30 - 39, 40 - 49, 50 - 59, 60 - 69 and over 70 years, the MbRs of T2DM were 2.5%, 5.8%, 12.3%, 22.0% and 21.8% populations, respectively (P < 0.01), and the MoRs by age groups in 2012 were 1.9%, 5.0%, 12.6%, 20.3% and 22.0% populations, respectively (P < 0.01). Moreover, the MbR of T2DM was the highest in the age group of over 50 years, and clearly showed higher occurrence both in 2009 and 2012.

On the other hand, trends in CF and MR of T2DM in Korea between 2009 and 2012 were compared by nationwide, gender and age groups as shown in Table 2. There were a total of 6,293 nationwide deaths related to T2DM, with an MR of 20.3 per 100,000 populations in 2009, and a total of 8,132 nationwide CF with an MR of 24.5 in 2012; the MR of T2DM increased (P < 0.01). In addition, males had a significantly increased MR of T2DM from 21.3 per 100,000 in 2009 to 25.6 in 2012 (P < 0.01), while in females from 19.2 per 100,000 in 2009 to 23.4 in 2012, respectively (P < 0.01).

The distribution of the MR with T2DM by age groups in 2009 was as follows: in the age groups of 30 - 39, 40 - 49, 50 - 59, 60 - 69 and over 70 years, the MRs of T2DM were 0.6, 2.8, 10.3, 31.0 and 121.3 per 100,000 populations, respectively (P < 0.01), and the MRs of T2DM by age groups in 2012 were 0.8, 2.4, 10.1, 31.0 and 163.0 per 100,000 populations, respectively (P < 0.01). Moreover, the MR of T2DM was the highest in the age group of over 70 years, and clearly showed a higher occurrence in 2012 than in 2009 (P < 0.01).

Mortality trends in the distribution rate (%) of CF and MR (per 100,000 per populations) of the most mortality type of T2DM were compared with respect to 10 keys (Codes from E11.0 and E11.9) of the ICD-10 Version 2014 (WHO). As shown in Table 3, a total of 6,293 CFs and 20.3 MR of T2DM in 2009 were analyzed; E11.0 (with coma: 1.8% of total CF and 0.3 of MR), E11.1 (ketoacidosis: 1.5% and 0.3 MR), E11.2 (renal complication: 12.0% and 2.4 MR), E11.3 (ophthalmic complication: 0.1% and 0.0 MR), E11.4 (neurological complication: 3.5% and 0.7 MR), E11.5 (peripheral circulatory: 6.6% and 1.3 MR), E11.6 (other specified: 9.4% and 1.8 MR), E11.7 (multiple complications: 28.5% and 5.5 MR), E11.8 (unspecified: 13.5% and 2.7 MR) and E11.9 (without complications: 23.1% and 4.7 MR), respectively. In 2012, a total of 8,132 CFs and 24.5 MR of T2DM were observed: E11.0 (2.1% and 0.52 MR), E11.1 (1.0% and 0.24 MR), E11.2 (14.5% and 3.56 MR), E11.3 (0.1% R 0.04 MR), E11.4 (2.4% and 0.59 MR), E11.5 (25.8% and 6.31 MR), E11.6 (1.1% and 0.27 MR), E11.7 (30.9% and 7.57 MR), E11.8 (6.6% and 1.61 MR) and E11.9 (15.4% and 3.77 MR), respectively (P < 0.01). Table 3 also shows the changes of CF and MR between 2009 and 2012; those for coma (+0.3% and +0.1 MR), renal (+2.5% and +1.2 MR), peripheral circulatory (+19.2% and +5.0 MR) and multiple complications (+2.4% and +2.1 MR) increased, while those ketoacidosis (-0.5% and -0.1 MR), other specified

(-8.3% and -1.5 MR), unspecified (-6.9% and -1.1 MR) and without complications (-7.7% and -0.9 MR) decreased, respectively ($P < 0.05$ to $P < 0.01$).

Discussion

Diabetes and its complications have become a major cause of morbidity and mortality in Korea that is still the fifth of the leading cause of death in Korea in the last decade [3-6]. However, in Korea, over the past three decades, a trend in the leading causes of death was declined [6]. Notwithstanding diabetes is still increasing up to now [3-5], while increased morbidity and mortality is likely attributable due to rapid economic development, improved living standards, aging, urbanization, and increasing prevalence of obesity and physical inactivity [1, 3]. Especially, the morbidity of T2DM is increasing globally and the International Diabetes Federation has predicted that the number of people with diabetes will increase from 366 million to 552 million by 2030 [1, 8].

In the present study, total nationwide MC with T2DM and MbR decreased slightly from 2009 to 2012 as shown in Table 1. However, CF with T2DM and MR significantly increased from 2009 to 2012 ($P < 0.01$). In the cases by the gender, the MC (%) of T2DM among men was much lower than women in both 2009 and 2012 ($P < 0.01$). However, in the cases by the gender, the MbRs (%) of T2DM in both males and females were not changed significantly between 2009 and 2012. Notwithstanding, in the 60 - 69 years old age group, the MbR of 2012 was significantly decreased than in 2009 ($P < 0.01$). Especially, the remarkable difference of MbR in gender with T2DM showed a pronounced female excess in the first half of last century but is now equally prevalent among men and women in most populations, with some evidence of male preponderance in early middle age. Women are, however, more likely to transmit T2DM to their offspring [1, 8], and the rate of CF of T2DM in age-specific groups is believed to be due to the difference between ages. The most important demographic change to prevalent diabetes appears to be the increased proportion of people who are old-aged [1-4, 9].

In the case of Korea, the total CF and MR of T2DM in 2012 increased compared to those in 2009 as shown in Table 2 ($P < 0.01$). In addition, the MR of T2DM of men was slightly higher than that of women; the latter are statistically at a significant level ($P < 0.05$). The remarkable difference of CF and MR of T2DM in gender is believed to be due to differences between men and women in terms of lifestyle between the sexes. However, recently data have also shown that men develop diabetes at a lower degree of obesity than women, a finding which adds support to the view that the pathogenesis of T2DM differs between men and women. Observation of sex differences in body fat distribution, insulin resistance, sex hormones, and blood glucose levels further supports this notion [1, 2, 6, 10, 11].

Moreover, in this study, the percentage distribution of the CF and MR of T2DM in the over 70 years age group was the highest in all age groups between 2009 and 2012. The remarkable differences of CF and MR in the older aged are believed to be due to differences that seem to blur almost imperceptibly into the large mass of elderly patients with non-immune diabetes [9]. For example, in the United States in 2011, 63% of the adults (aged 10 - 79) with incident cases of diabetes were diagnosed between the ages of 40 and 64 years. About 16% were diagnosed at 18 - 39 years, and about 21% were diagnosed at 65 - 79 years [12].

Trends in CF and MR among adults with T2DM by ICD (Codes from E11.0 to E11.9) in Korea are shown in Table 3, and the changes from 2009 to 2012 are as follows: T2DM with coma, with renal complications, with peripheral circulatory complications and with multiple complications tended to increase in 2012 than those in 2009, while T2DN with ketoacidosis, with other specified complications and unspecified complications were decreased in 2012. These changes in the pattern of prevalent data strongly indicate that they are likely attributed to rapid economic development, improved living standards, and aging population, and with increasing obesity [1-3, 12, 13].

The remarkable changes in the rate of CF of T2DM in age-specific groups are believed to be due to differences between ages. The most important demographic change to prevalent diabetes appears to be the increased proportion of people who are old-aged [1-4].

In the present study, it was obvious that T2DM increased significantly in 2012 (8,132 CF and 24.5 MR) compared to in 2009 (6,293 CF and 18.4 MR). Therefore, control measures should focus on the growing prevalence of T2DM. Despite much evidence that diabetes can be prevented or delayed with lifestyle changes and weight loss or certain physical and health activities to combat increasing obesity, improved longevity, diabetes and prediabetes are expected to dramatically increase more than previously projected [1-3, 13].

In conclusion, as T2DM is one of the most severe and relatively common chronic diseases worldwide, including Korea, more efforts should be made towards prevention through raising awareness of the risk of diabetes. Because of its rapid aggravation and increasing prevalence with high CF and MR, public health education about diabetes is strongly recommended for avoiding diabetes. In the present study, we provided useful quantitative cross-section analysis of recent epidemiological trends in the mortality of T2DM among adults in Korea between 2009 and 2012. It is our hope that this information would be a useful reference for the further studies of diabetes in the field of public health and epidemiology.

Conflicts of Interest

The authors have no conflicts of interest to disclose.

References

1. World Health Organization (WHO) (2015): Diabetes. Media Centre, Fact Sheet No 312. Geneva, WHO, 2015. Available at http://www.who.int/mediacentre/factsheets/fs312/en/.
2. 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. 2004;27(5):1047-

1053.
3. Kim DJ. The epidemiology of diabetes in Korea. Diabetes Metab J. 2011;35(4):303-308.
4. Korea Center for Disease Control and Prevention (KCDC)(2009 & 2012): Korea Health Statistics: Korea National Health and Nutritional Examination Survey (KNHANES-IV, 2009 & -V, 2012), KCDC. Available at http://www.cdc.go.kr/ (in Korean).
5. Korea Statistics Promotion Institute (KSPI) (2009-2012): Diabetes. Annual Report on the Cause of Death Statistics, Statistic Korea, 2009 and 2012. (in Korea). Available at http://www.stat.or.kr/.
6. Lim D, Ha M, Song I. Trends in the leading causes of death in Korea, 1983-2012. J Korean Med Sci. 2014;29(12):1597-1603.
7. World Health Organization (WHO)(2015): International Classification of Diseases, Reversion (ICD-10)- WHO, 2014.
8. Goto A, Goto M, Noda M, Tsugane S. Incidence of type 2 diabetes in Japan: a systematic review and meta-analysis. PLoS One. 2013;8(9):e74699.
9. Gale EA, Gillespie KM. Diabetes and gender. Diabetologia. 2001;44(1):3-15.
10. Kristine F. (2014): Gender and T2DM [internet]. Diapedia, rev. no. 10.
11. Geer EB, Shen W. Gender differences in insulin resistance, body composition, and energy balance. Gend Med. 2009;6(Suppl 1):60-75.
12. Center for Disease Control and Prevention (CDC) (2015): Distribution of Age at Diagnosis of Diabetes among Adults Incidence Cases Aged 18-79 Years, United State, 2011. CDC 24/7: Saving Lives. Protecting People. http://www.cdc.gov/diabetes/statistics/age/fig1.htm.
13. Cho NH. The epidemiology of diabetes in Korea: from the economics to genetics. Korean Diabetes J. 2010;34(1):10-15.

