



Trends in Diabetes Incidence in the Last Decade Based on Korean National Health Insurance Claims Data

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Background: Epidemiological data is useful to estimate the necessary manpower and resources used for disease control and prevention of prevalent chronic diseases. We aimed to evaluate the incidence of diabetes and identify its trends based on the claims data from the National Health Insurance Service database over the last decade.

Methods: We extracted claims data on diabetes as the principal and first additional diagnoses of National Health Insurance from January 2003 to December 2012. We investigated the number of newly claimed subjects with diabetes codes, the number of claims and the demographic characteristics of this population.

Results: Total numbers of claimed cases and populations with diabetes continuously increased from 1,377,319 in 2003 to 2,571,067 by 2012. However, the annual number of newly claimed diabetic subjects decreased in the last decade. The total number of new claim patients with diabetes codes decreased as 30.9% over 2005 to 2009. Since 2009, the incidence of new diabetes claim patients has not experienced significant change. The 9-year average incidence rate was 0.98% and 1.01% in men and women, respectively. The data showed an increasing proportion of new diabetic subjects of younger age (<60 years) combined with a sharply decreasing proportion of subjects of older age (≥60 years).

Conclusion: There were increasing numbers of newly claimed subjects with diabetes codes of younger age over the last 10 years. This increasing number of diabetic patients will require management throughout their life courses because Korea is rapidly becoming an aging society.

Keywords: Diabetes; Incidence; Claims data; Korea

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INTRODUCTION

Diabetes mellitus (DM) is one of the most common and rapidly increasing chronic metabolic disorders in the world. In 2013, more than 382 million people had diabetes worldwide [1], corresponding to 8.3% of all adults. This number is expected to increase to 592 million about 10% individuals by 2035 [1]. Diabetes can cause serious complications and mortality, resulting in a large burden to the public health care system as well as to patients.

The management of patients with diabetes is a major challenge for health care systems. From the public health perspective, epidemiological data is useful to estimate the necessary manpower and resources needed for disease control and prevention of common chronic diseases. In the absence of reliable population-based data on diabetes, nationwide claims data can provide credible evidence for investigating the actual epidemiologic status and the medical cost of diabetes [2]. Claims data include a large population-based longitudinal registry and are widely used in epidemiology and health services research [3]. In Korea, a universal coverage was achieved by the government in 1989 and provides coverage for nearly 100% of the total population [2]. In 2013, the National Health Insurance system covered 97.2% ($n=49,989,620$) of the whole population in Korea, and the medical aid system covered the remaining 2.8% ($n=1,458,871$).

Because of the significant impact of diabetes on public health, the incidence of diabetes and associated annual medical claim cases in the general population of Korea has been investigated. Studies in initial stage have been carried out to examine the epidemiology of diabetes in Korea based on urban or rural community cohorts [4-8]. Recently, the Task Force Team for Basic Statistical Study of Korean Diabetes Mellitus from the Korean Diabetes Association has reported a 12.4% prevalence of diabetes in adults aged older than 30 years based on the nationwide Korea National Health and Nutrition Examination Survey (KNHANES) [9]. Although the KNHANES is a well-designed survey that reflects representative citizens in Korea, it does not assess trends in diabetes incidence or the status of medical care utilization in diabetic patients in Korea. Korean diabetes fact sheets 2015 showed that the prevalence of diabetes steadily increased from 5.6% in 2006 to 8.0% in 2013 from the health insurance claim forms made by National Health Insurance Service (NHIS) [10]. However, we could not find the incidence of diabetes. The latest study showed that the incidence decreased from 9.8/1,000 person-year in 2009 to 9.5/1,000 person-year in 2011 and preva-

lence of type 2 diabetes mellitus (T2DM) increased from 6.1% in 2008 to 6.9% in 2010 using the Health Insurance Review and Assessment database [11].

Therefore, we aimed to evaluate trends in the annual medical claims in diabetic patients and the incidence of diabetes in the general population of Korea using nationwide claims data from the NHIS database over the last decade.

METHODS

Data source

A universal compulsory NHIS program was launched by integration of Medical Insurance Societies under the Korean government in February 1999. The NHIS program is mandatory and covered the entire population in Korea (51 million) as of 2013. This study was based on the compulsory health insurance claims from the NHIS claims database. The NHIS claims database provided data after de-identification; claims case data contained date of birth, region of residence, gender, and date of hospital visit. The protocol was reviewed and approved by the Institutional Review Board of National Health Insurance Service Ilsan Hospital (SUYON 2014-036).

Study population

Using the NHIS claims database from January 1, 2003 to December 31, 2012, DM patients were defined as those who claimed DM as a principal or first additional diagnosis. Principal and first additional diagnosis statements were determined by the International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM) code for diabetes (E1000–E1090, type 1 diabetes mellitus; E1100–E1190, T2DM; E1200–E1290, malnutrition-related diabetes, type 3 diabetes mellitus; E1300–E1390, diabetes associated with other disease, other diabetes; E1400–E1490, diabetes type unknown, unknown diabetes). The data was extracted on August 30, 2014.

To obtain nationwide data on the incidence of diabetes, we extracted the new claims with DM codes in each studied year. For detailed analysis of the diabetic population in Korea, stratification by gender and age group (0 to 9, 10 to 19, 20 to 29, 30 to 39, 40 to 49, 50 to 59, 60 to 69, 70 to 79, and 80 years or older) was performed.

Statistical analysis

All data were analyzed using SAS software version 9.3 (SAS Institute Inc., Cary, NC, USA). Age- and gender-specific annual incidence of DM from 2004 to 2012 were calculated by di-

viding the number of DM patients by the Korean population from the Korea Census Statistics (<http://kostat.go.kr/portal/english/index.action>). The age- and gender-specific annual incidence rates (number of newly claimed subjects in each year/number of individuals in the chosen age range) were calculated. The annual trends in number of claimed cases and incidence were explored using chi-square test for trends within age-gender strata. We applied time series analysis to forecast the annual number of claims cases and newly claimed DM patients. A $P < 0.05$ was considered statistically significant.

RESULTS

Trends in number of claim patients with diabetes by year

Table 1 describes the 10-year trend in number of annual claim patients with diabetes from 2003 to 2012. During this time period, the total number of claim patients with diabetes increased by an average of 186.7%. In 2003, the total number of claim patients with diabetes was 1,377,319, with a greater proportion of females (women, 703,926 [51.1%]). However, this number increased to 2,571,067 by 2012, with a greater proportion of males (men, 1,320,715 [51.4%]). Males have accounted for more than 50% of diabetic claim patients since 2008, which may be attributed to the relatively rapid increase of male patients with diabetes (196.1% [177.6%] increase from 2003 to 2012 in men [women]).

Trends in number of total claim cases for diabetes by year and average annual claim cases per patient-year

The total number of claim cases for diabetes dramatically in-

creased from 8,351,674 in 2003 to 22,777,110 in 2012 (Table 2), representing a 272.7% increase over 10 years. In terms of gender analysis, there was a greater increase in total number of claim cases in men compared to women (286.1% in men vs. 260.6% in women), which is consistent with the findings above. In 2003, the total number of claim cases for diabetes in females was much higher than that in males (52.5% female vs. 47.5% male). Over the next 10 years, this gender gap was gradually reduced, resulting in relatively similar proportions of male and female patients in 2012 (50.1% female vs. 49.9% male).

The average annual claim cases per patient were calculated by dividing the number of total diabetes claim cases by the number of diabetes claim patients (Supplemental Table S1). The average was 6.1 ± 5.6 claim cases per patient-year in 2003, which rapidly increased up to 9.0 ± 10.3 claim cases per patient-year in 2008 and then held steady to 2012. This implies that the average interval of clinic visits decreased from approximately 60 days in 2003 to 40 days in 2012.

Trends in incidence of new claim patients with diabetes by year

Table 3 shows the incidence of new diabetes claim patients from 2004 to 2012 according to gender. The total number of new claim patients with diabetes codes abruptly increased in 2005 (from 562,440 in 2004 to 643,395 in 2005) and then gradually decreased until 2009 (444,452 in 2009), showing a 30.9% decrease in diabetes incidence over these 5 years (2005 to 2009, P for trend < 0.0001). Since 2009, the incidence of new diabetes claim patients has not experienced significant change. The maximal (peak) incidence rate was 1.28% and

Table 1. Trends in the Number of Diabetes Claim Patients by Year

Year	Men, <i>n</i> (%)	Women, <i>n</i> (%)	Total
2003	673,393 (48.89)	703,926 (51.11)	1,377,319
2004	744,819 (49.53)	758,870 (50.47)	1,503,689
2005	887,835 (49.59)	902,613 (50.41)	1,790,448
2006	949,990 (49.6)	965,468 (50.4)	1,915,458
2007	1,007,135 (49.94)	1,009,588 (50.06)	2,016,723
2008	1,057,393 (50.18)	1,049,732 (49.82)	2,107,125
2009	1,103,528 (50.38)	1,087,072 (49.62)	2,190,600
2010	1,168,993 (50.64)	1,139,352 (49.36)	2,308,345
2011	1,253,620 (50.96)	1,206,332 (49.04)	2,459,952
2012	1,320,715 (51.37)	1,250,352 (48.63)	2,571,067

Table 2. Trends in the Number of Total Diabetes Claim Cases by Year

Year	Men, <i>n</i> (%)	Women, <i>n</i> (%)	Total
2003	3,968,411 (47.52)	4,383,263 (52.48)	8,351,674
2004	4,510,704 (48.28)	4,832,272 (51.72)	9,342,976
2005	5,379,721 (49.14)	5,567,347 (50.86)	10,947,068
2006	6,105,981 (48.74)	6,422,251 (51.26)	12,528,232
2007	7,704,612 (47.90)	8,381,517 (52.10)	16,086,129
2008	9,006,979 (47.73)	9,862,716 (52.27)	18,869,695
2009	9,449,227 (48.07)	10,207,780 (51.93)	19,657,007
2010	9,875,313 (48.44)	10,510,536 (51.56)	20,385,849
2011	10,506,851 (49.03)	10,923,602 (50.97)	21,430,453
2012	11,355,282 (49.85)	11,421,828 (50.15)	22,777,110
Total	77,863,081 (48.55)	82,513,112 (51.45)	160,376,193

1.36% in men and women, respectively, occurring in 2005. The 9-year average incidence rate was 0.98% and 1.01% in men and women, respectively. The gender-specific incidence rate of diabetes decreased more rapidly in women, resulting in a rate of 0.82% in 2012 compared to 0.85% for men.

Age distribution in new claims cases with diabetes codes by year

Next, we assessed the average age of new diabetes claim patients by year and gender (Table 3). Overall, in a total of 5,828,450 individuals, the average age of new claim patients with diabetes (from 2003 to 2012) was 64±15 years. After gender-specific analysis, men tended to be younger than women at the time of the first claim for diabetes. The median age of new diabetes claim patients was 64±19 years in men and 68±21 years in women in 2004. During 9 years of follow-up, the median age of new diabetes claim patients steadily decreased by an average of 6 years regardless of gender (*P* for trend <0.001). In 2012, the median age was 57±19 years in men and 61±20 years in women, a statistically significant difference between gender (*P*<0.001).

From 2003 to 2007, the majority of new diabetes claim patients were between 70 and 79 years of age (Fig. 1). However, the average age of the majority of new claim patients began to decrease from 2006 such that, since 2008, individuals aged 50 to 59 years have accounted for the largest proportion of new diabetes claim patients. This is due to the rapid decrease in the number of new claim patients older than 60 years (from 137,545+144,557+90,060 in 2004 to 98,399+75,061+29,736 in 2012), whereas there was no decrease in subjects in their 50s

during the past 9 years (from 113,804 in 2004 to 117,934 in 2012). In particular, changes in the number of new claim patients showed contrasting patterns in the younger and older age groups. Numbers of new claim patients with diabetes dramatically increased among those aged 10 to 49 years (106% in 10s, 34% in 20s, 53% in 30s, and 25% in 40s, when comparing 2004 and 2012). Meanwhile, the number of new claim patients older than 60 years decreased (−28% in 60s, −48% in 70s, and −67% in over 80, when comparing 2004 and 2012).

Prediction of annual number of claim patients with diabetes

Fig. 2 demonstrates the observed and predicted number of an-

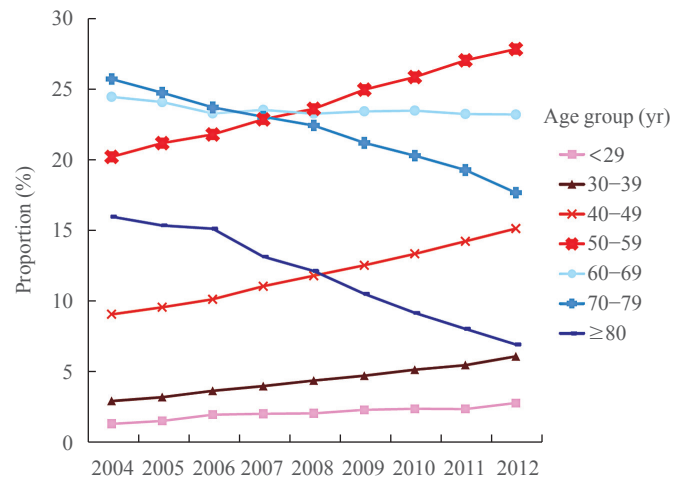
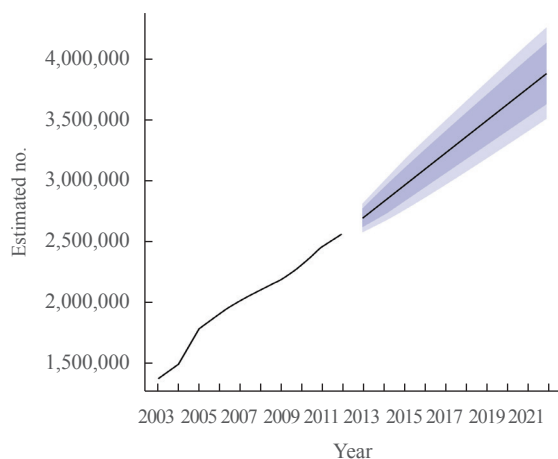


Fig. 1. Changes in the age of new claim patients from 2004 to 2012. Age distribution of new claim patients from 2004 to 2012.

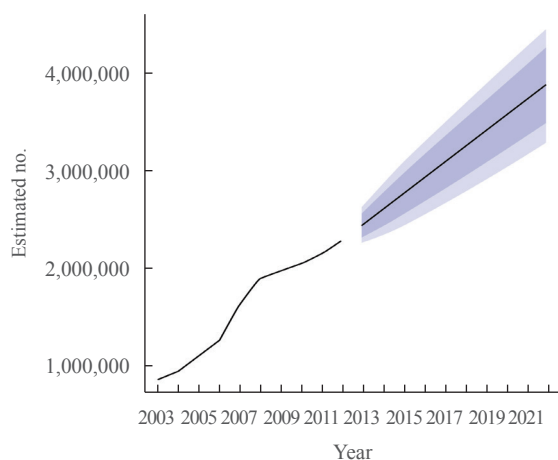
Table 3. Incidence of New Diabetes Claim Patients by Year and Gender

Year	Total population		Men			Women		
	Number	Newly claimed patients, n (%)	Number	Newly claimed patients, n (%)	Age, yr, mean±SD	Number	Newly claimed patients, n (%)	Age, yr, mean±SD
2004	48,583,805	562,440 (1.16)	24,363,083	280,629 (1.15)	64±19	24,220,722	281,811 (1.16)	68±21
2005	48,782,274	643,395 (1.32)	24,456,234	313,527 (1.28)	63±19	24,326,040	329,868 (1.36)	68±20
2006	48,991,779	549,090 (1.12)	24,557,004	266,983 (1.09)	62±19	24,434,775	282,107 (1.16)	68±21
2007	49,268,928	495,668 (1.01)	24,691,249	243,714 (0.99)	61±20	24,577,679	251,954 (1.03)	66±21
2008	49,540,367	495,668 (1.00)	24,822,897	227,069 (0.92)	60±20	24,717,470	234,465 (0.95)	66±21
2009	49,773,145	444,452 (0.89)	24,929,939	219,945 (0.88)	59±19	24,843,206	224,507 (0.90)	64±21
2010	50,515,666	429,256 (0.85)	25,310,385	214,112 (0.85)	59±19	25,205,281	215,144 (0.85)	63±21
2011	50,734,284	441,361 (0.87)	25,406,934	222,630 (0.88)	58±19	25,327,350	218,731 (0.86)	62±20
2012	50,948,272	423,935 (0.83)	25,504,060	215,791 (0.85)	57±19	25,444,212	208,144 (0.82)	61±20
Total	447,138,520	4,451,131 (1.00)	224,041,785	2,204,400 (0.98)	-	223,096,735	2,246,731 (1.01)	-



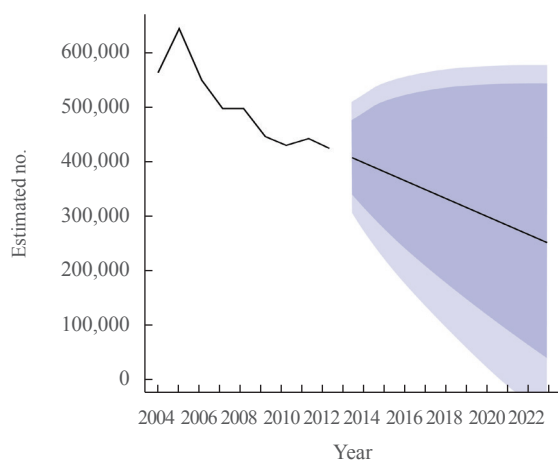
Year	Estimates	80% CI	95% CI
2015	2,968,983	2,832,871–3,105,095	2,760,818–3,177,148
2020	3,632,176	3,409,906–3,854,446	3,292,244–3,972,109

A



Year	Estimates	80% CI	95% CI
2015	27,585,589	25,451,166–29,720,011	24,321,272–30,849,906
2020	35,599,720	32,114,223–39,085,217	30,269,112–40,930,327

B



Year	Estimates	80% CI	95% CI
2015	354,682	220,421–488,943	149,347–560,017
2020	268,116	66,725–469,508	–39,885–576,118

C

Fig. 2. Observed and predicted annual numbers of diabetes claim patients and cases. (A) Observed and predicted annual numbers of total diabetes claim patients. (B) Observed and predicted annual numbers of total diabetes claim cases. (C) Observed and predicted annual incidence of new diabetes claim patients. CI, confidence interval.

nual diabetes claim patients or cases in Korea. There has been a steady increase in the annual number of total diabetes claim patients and cases in the period from 2003 to 2012. If this rate of increase continues, the estimated annual number of total diabe-

tes claim patients will increase from 2,571,067 in 2012 to 2,968,983 in 2015 and to 3,632,176 in 2020 (141% estimated increment from 2012 to 2020) (Fig. 2A). Moreover, the estimated annual number of total diabetes claim cases is expected to in-

crease from 22,777,110 in 2012 to 27,585,589 in 2015 and to 35,599,720 in 2020 (156% increment from 2012 to 2020) (Fig. 2B). Contrarily, the estimated annual number of new diabetes claim patients will decrease from 423,935 in 2012 to 354,682 in 2015 and to 268,116 in 2020 if the current decline continues (66% estimated decrement from 2012 to 2020) (Fig. 2C).

DISCUSSION

In this nationwide study using claims data, we investigated the trends in the annual incidence of diabetes and the number of medical claims and patients with diabetes in the general population of Korea. During the 10 years from 2003 to 2012, the annual number of diabetes claim patients continuously increased by 186.7%, resulting in 2,571,067 individuals in 2012. Furthermore, the annual number of total claim cases for diabetes dramatically increased by 272.7% over this period, which can be attributed to the increase in the average number of claim cases per patient. However, the incidence of new diabetes claim patients gradually decreased from 2005 to 2009 and has remained steady since 2009, resulting in an overall 30.9% decrease from 2005. The average age of new claims subjects with diabetes codes decreased from 64 and 68 years in men and women, respectively, in 2004 to 57 and 61 years in 2012.

Although the prevalence of diabetes is influenced by diagnostic method and criteria, it has dramatically increased by 6.6-fold from 1.5% to 9.9% in the past 40 years in Korea [4]. A recent paper based on data from the KNHANES 2011 reported that the prevalence of diabetes was 12.4% (estimated number of subjects with diabetes in 2011 [4,006,686]) in Korean adults older than 30 years [12]. In agreement with these statistics, we observed a steady increase in the annual number of total claim patients with diabetes, though this increase is lagging behind the estimated number of subjects with diabetes in Korea. In 2011, a total of 2,459,952 people visited a hospital for diabetes, accounting for only 61% (2,459,952/4,006,686) of subjects with diabetes. This low proportion may have several causes: (1) subjects with undiagnosed diabetes [13]; (2) subjects with known diabetes who do not receive treatment [14]; (3) inaccurate coding for diabetes by medical professionals; and (4) differences in research design and methods.

Our report found that the increase in annual number of total claim cases for diabetes outnumbered that of total diabetes claim patients. This can be explained by the increase in the average number of claim cases per patient-year from 6.1 to 8.9 over the 10 studied years. Economic development, increased

public interest in health-care, and changes in health policies that expanded health insurance coverage may have all influenced the increase in total number of diabetes claim cases [15]. Moreover, subjects with a longer duration of diabetes are likely to have more comorbidities that may require frequent hospital visits for medical care [14]. Further detailed investigation should be implemented to examine the overall characteristics of patients with diabetes in Korea. In terms of gender differences, a relatively rapid increase in the annual number of diabetes claim patients from 2003 to 2012 was seen in men (196.1%) compared to women (177.6%). Similarly, the annual number of total diabetes claim cases also increased more in men (286.1%) than in women (260.6%) during the 10-year interval.

Although the prevalence of diabetes and annual number of claim patients with diabetes in Korea steadily increased during the last 10 years, the incidence of new claim patients has remained steady since 2009. The maximal incidence rate was 1.28% and 1.36% in men and women, respectively, in 2005 compared to 0.85% and 0.82% in 2012. Similar findings were observed in a nationwide population-based pharmacoepidemiological study in Sweden [16]. A previous study reported that the estimated incidence of diabetes among Korean adults aged 20 to 79 years was 0.76% in 2003 [14]. A community cohort study by Cho [6] showed that the annual incidence range of T2DM was 1.33% to 2.35% in those in their 40s, 1.48% to 3.18% in those in their 50s, 1.85% to 4.55% in those in their 60s, and 3.08% to 5% in those in their 70s. Consistent with our findings, Koo et al. [11] reported a decrease in the incidence of T2DM from 0.98% in 2009 to 0.95% in 2011. However, the prevalence of obesity has gradually increased in Korean adults aged ≥ 19 years from 26.9% in 1998 to 32.0% in 2011 [17]. This discrepancy may be due to earlier detection of diabetes with improved accessibility to primary medical care and the establishment of the National Health Screening Exam (NHSE). Since 2000, the health insurance systems in Korea have been incorporated into a unified system operated by the NHIS [2]. As part of the NHIS health-care system, all insurance subscribers are allowed a free biannual NHSE [18]. According to the report of Ministry of Health and Welfare, the rate of undergoing NHSE was 35% in 1999, 48% in 2003, 55% in 2006, and 65% in 2008, there has been increased up to 71% in 2011 and 2012. However, increasing health check-up rate can be hardly expected to increase in number of new diabetes patients, the assumed reasons as follows: First, the increment of screening rate was rapidly increasing 20% from 1999 to 2008, and then it showed only 5% after 2008. This screening rate almost reached

a plateau [19]. Second, the increasing proportion of examination subjects is occupied by previous examiners and the people who already have the disease including diabetes and hypertension [19]. Therefore, additional diagnosis of new diabetes may be reduced. In addition, the health checkup rate of younger ages increased because of increasing interests of health through various media; however, the proportion of young diabetes patients in young population is significantly lower than in the old age. As well as, the changing demographic structure of our country seems to be associated. As progressing aging country, the elderly populations are increasing; in contrast, young populations are actually shrinking.

While the number of new diabetes claim patients did not significantly change over the last 4 years, the average age of new diabetes claim patients has decreased by 6 years from 2003 to 2012, regardless of gender. Furthermore, the age range of the majority of new diabetes claim patients has decreased from the 70s in 2003 to 2007 to the 50s in 2008 to 2012. These findings imply two possibilities: (1) the age at initial diagnosis of diabetes decreased due to diabetes awareness campaigns, positive attitudes for individual health-care, and enhanced accessibility of primary medical care and NHSE [15] or (2) diabetes developed at an earlier age due to increased obesity in younger adults [17].

The present study demonstrates a steady increase in the annual number of total diabetes claim patients and cases during the last 10 years. Although the fit of the models was not ideal, this data suggests that a further 1.4- to 1.6-fold increase in the number of total diabetes claim patients and cases can be expected in 2020. This translates into a future increase in medical expenses for the management of patients with diabetes in Korea, which should be considered a crucial issue for health-care providers.

The current study has several limitations that should be addressed by further investigation. We defined subjects as having diabetes based on the diagnosis information from the claims data without considering medication prescription data. Therefore, we were unable to calculate the prevalence of diabetes from the latter dataset. Furthermore, the typical limitations of research based on a medical claims database also apply to our study. Only subjects who actively utilized health care and were able to access medical personnel were represented in the NHIS data and analyzed in this study. Thus, the actual incidence rate of diabetes may be underreported due to individuals with undiagnosed diabetes. Lastly, the accuracy of diagnosis coding for diabetes in the claims data has not been intensively validated

by independent research such as confirmation with laboratory data or medical records. Despite these limitations, the present study demonstrates for the first time trends in the annual number of total diabetes claim patients and cases in Korea from 2003 to 2012. The use of the claims database illustrates actual changes in claims patterns in clinical practice in Korea. Furthermore, we analyzed trends by gender and age groups and predicted the future number of claim patients and cases with diabetes.

In summary, there have been increasing numbers of diabetes claim subjects and cases in Korea in the last 10 years, although the annual number of new diabetes claim patients did not increase during the last 4 years. Considering the fact that new claim subjects with diabetes are getting younger, the number of patients with a longer duration of diabetes who are at higher risk for related comorbidities will gradually increase. Thus, it is necessary for health-care policy makers to establish a long-term health-care management plan for preventing chronic diabetic complications.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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