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Trends in diabetic retinopathy and related medical practices among type 2 diabetes patients: Results from the National Insurance Service Survey 2006–2013

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ABSTRACT

Aims/Introduction: The present study aimed to analyze the temporal changes in the prevalence, screening rate, visual impairments and treatment patterns of diabetic retinopathy in the Korean population over 8 years.

Materials and Methods: This was a retrospective population-based study of Korean national health insurance beneficiaries aged 30 years or older with type 2 diabetes, obtained from the Korean National Health Insurance Claims database from 2006 to 2013 (n = 1,655,495 in 2006 and 2,720,777 in 2013). The annual prevalence rates of diabetes, diabetic retinopathy, dilated fundus examinations, visual impairment, laser treatment and vitrectomy, as determined based on diagnostic and treatment codes, were analyzed.

Results: There was a steady increase in the prevalence of diabetic retinopathy, from 14.3% in 2006 to 15.9% in 2013. However, the incidence of new diabetic retinopathy cases decreased from 6.7/100 person-years in 2006 to 5.6 in 2013. Approximately 98% of patients underwent at least one dilated fundus examination during the follow-up period. The prevalence of diabetic retinopathy peaked in the 60–69 years age group. The prevalence of diabetic retinopathy was higher in female than in male diabetes patients. The proportion of patients who underwent an annual dilated fundus examination improved from 24.3% in 2006 to 30.0% in 2013. Among patients with diabetic retinopathy, constant decreases in the proportions of those who received laser treatment (11.4% in 2006 to 6.9% in 2013) and who underwent vitrectomy (2.4% in 2006 to 1.7% in 2013) were noted. Additionally, a decreasing trend in the prevalence of visual impairment was noted among the patients with diabetic retinopathy, from 2% (4,820/237,267) in 2006 to 0.08% (3,572/431,964) in 2013.

Conclusions: Although there was a rapid increase in the prevalence of diabetes in the Korean population in the past decade, the prevalence of diabetic retinopathy remained stable during the study period. However, just three out of 10 patients with diabetes underwent regular annual dilated fundus examinations. Thus, an improvement in the continuity of diabetic retinopathy screening among patients with diabetes is necessary to reduce the risk of visual impairment as a result of diabetic retinopathy.

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INTRODUCTION

Diabetic retinopathy (DR) is the major cause of visual impairment worldwide[1–3]. An increase in the number of cases of DR has been predicted, owing to an increase in the prevalence of diabetes[4]. However, recent studies have shown that the prevalence of visual impairment and severe DR has decreased in the past few decades[5–7]. The decline in the prevalence of visual impairment among patients with type 1 diabetes is thought to have resulted from improvements in the glycemic control of the patients and from aggressive treatment of high blood pressure[5]. In addition, improved education and screening programs for diabetes have helped ensure early detection and timely treatment of patients at high risk for DR[5–7].

Unlike for type 1 diabetes, few studies investigating the changes in the prevalence of DR in type 2 diabetes patients have been carried out, although a decreased trend for the prevalence of severe DR has been reported[8]. Furthermore, until now, there have been no studies evaluating the comprehensive changing trends, including the prevalence, screening rate and treatment for DR, over a specific time-period. It is crucial not only for ophthalmologists, but also for medical care providers to understand the recent changes in the prevalence of DR and the associated medical practices, as this knowledge will provide important clinical information for the design or modifications of future public health policies regarding DR and diabetes. Therefore, in 2014, the Korea Diabetes Association, in association with the Korean National Health Insurance Service, carried out a study to analyze the rates of diabetes and any related medical claims for the entire Korean population from 2006 to 2013. Based on these data, the present study assessed the prevalence, screening rate and related treatment claims for DR in the entire Korean population.

METHODS

Participants

For the present study, we collected information from the National Health Insurance Service (NHIS) insurance claims database (No. NHIS-2015-4-008) from 2006 to 2013. The study was approved by the institutional review board of the Korean National Institute for Bioethics Policy (P01-201504-21-005), and the need for informed consent was exempted by the board. The study was carried out in accordance with the Declaration of Helsinki.

In Korea, 97% of the population is covered by compulsory health insurance from the NHIS[9,10]. Both outpatient and inpatient claims are reviewed by the NHIS, which include data regarding diagnoses, procedures, prescription records, demographic information and direct medical costs[9,10]. The NHIS also reviews claims from the Medical Assistance Program and the Medical Care for Patriots and Veterans Affairs Scheme, which cover the medical expenses of the Korean population not insured by the NHIS[9,10]. Therefore, the NHIS database covers the entire Korean population, and contains information about all medical claims made in Korea[9,10]. The NHIS identifies its members by their Korean Resident Registration Number, which removes the risk of duplication or omission when accessing the data.

Criteria for defining diabetes, DR, screening, visual impairment and treatment of DR

The NHIS database manages claims using the Korean Classification of Disease, sixth edition, a modified version of the International Classification of Diseases, 10th edition (ICD-10), adapted for the Korean healthcare system. For the present study, we identified DR cases registered from 2006 through 2013 using the first DR diagnostic code (H36.8)[11]. The date of the earliest and first ever claim related to DR diagnostic code was defined as the index date, and the patient was considered an incident case in that year. To eliminate the possibility of including any previous cases with DR before 2006, we excluded cases that had a DR diagnostic code during 2002–2005.

DR was identified by the presence of any characteristic lesion, including microaneurysms, hemorrhages, hard exudates, cotton wool spots, intraretinal microvascular abnormalities, venous beading and new retinal vessels. The prevalence of DR was calculated as the mean number of people with medical claims for DR (H36.0) divided by the total number of people with diabetes (E11–E14) each year. The incidence of DR was calculated as the mean number of new cases of DR without previous claims of DR (H36.0) divided by the total number of people with diabetes (E11–E14) each year[11].

In Korea, according to the National Handicapped Registry, in which patients with visual acuity impairments are registered to receive socioeconomic benefits, the severity of visual impairment can be divided into six degrees. In the present study, cases of visual impairment were defined as new patients who registered with the National Handicapped Registry for claims regarding DR and had a best-corrected visual acuity of less than 0.1 during the study period. If the visual impairment degree changed during the study period, the worst degree was used for statistical analysis.

The diagnosis of type 2 diabetes (ICD-10 codes E11–E14), included a principal diagnosis and up to four additional accompanying diagnoses[11]. Patients were classified as having type 2 diabetes, and were included in this study if they were aged 30 years or older, had at least one service claim for type 2 diabetes, had received either outpatient or inpatient care for type 2 diabetes and were prescribed at least one antidiabetic drug at any time in the given year[11].

Annual screenings for DR in a given year were accounted for by identifying the person-specific claims from patients with diabetes for dilated fundus examination (E6660, E6670 and E6681) in that year. Laser treatments associated with DR were

accounted for by identifying the claims from patients with diabetes (E11-E14) and DR (H36.0) undergoing panretinal photocoagulation or endolaser photocoagulation (S5160 or S5161). Vitrectomy associated with DR was accounted for by identifying the claims of diabetes (E11-E14) and DR (H36.0) patients treated by pars plana vitrectomy (S5121).

Statistical analysis

The mean annual DR prevalence was calculated as the number of persons with DR divided by the total population, based on the 2010 census. Statistical Analysis System software version 9.3 (SAS Inc., Cary, North Carolina, USA) was used for all analyses.

RESULTS

DR prevalence in 2006–2013

The prevalence of DR in 2006–2013 is presented in Table 1. As the age of the population with diabetes increased, the prevalence of DR increased and reached a maximum in the 60–69 years age group. There was a steady increase in the overall prevalence of DR, from 14.3% in 2006 to 15.9% in 2013 ($P < 0.001$). The prevalence of DR according to sex is shown in Figure 1. The prevalence of DR was higher in women (16.0–17.7%) than in men (12.7–14.3%) throughout the study period. The mean age at the development of DR in female diabetes patients was 63 ± 11 years in 2006 and 64 ± 12 years in 2013, which was higher than that in their male counterparts (58 ± 11 years in 2006 and 59 ± 11 years in 2013).

DR incident new cases in 2006–2013

The new cases of DR decreased from 6.7/100 person-years in 2006 to 5.6/100 person-years in 2013. The incident new cases of DR were higher in women (5.8–7.5/100 person-years) than in men (5.1–6.1/100 person-years) throughout the study period (Figure 2).

DR annual screening rates in 2006–2013

Approximately 98% (n = 3,600,073) of the total patients underwent at least one dilated fundus examination during the study period. Furthermore, 80% (n = 2,953,486) of the patients underwent dilated fundus examinations every 2 years. Although the proportion was much lower, there was a steady increase in the proportion of patients who underwent annual dilated fundus examinations every year, from 24.3% in 2006 to 30% in 2013 (Table 2).

Treatment patterns for DR in 2006–2013

The numbers and proportions of patients who received laser treatment or vitrectomy among patients with DR are presented in Table 3.

Although the number of patients who received laser treatment or underwent vitrectomy increased, there was a constant decrease in the overall percentage of these patients. In 2013, among the patients with DR, 1.7% underwent vitrectomy and

Table 1 | Prevalence of diabetic retinopathy in various age groups in 2006–2013

Age group (years)	Year								
	2006 (%)	2007 (%)	2008 (%)	2009 (%)	2010 (%)	2011 (%)	2012 (%)	2013 (%)	
n 30–39	64,796/6,394 (9.9)	66,688/6,764 (10.1)	68,377/7,053 (10.3)	70,001/6,948 (9.9)	70,481/7,372 (10.5)	71,727/7,699 (10.7)	71,069/7,730 (10.9)	71,470/7,742 (10.8)	
n 40–49	249,009/28,061 (11.3)	262,036/29,459 (11.2)	277,819/31,911 (11.5)	288,219/31,943 (11.1)	290,576/33,281 (11.5)	297,463/35,433 (11.9)	299,482/35,621 (11.9)	307,312/36,503 (11.9)	
n 50–59	429,192/60,523 (14.1)	464,323/64,629 (13.9)	506,618/72,149 (14.2)	551,386/76,469 (13.9)	597,287/83,906 (14)	653,863/94,639 (14.5)	682,204/97,324 (14.3)	712,835/101,818 (14.3)	
n 60–69	510,613/86,682 (17.0)	553,737/93,867 (17.0)	593,965/103,739 (17.5)	627,910/108,568 (17.3)	662,772/116,318 (17.6)	689,739/125,629 (18.2)	712,975/129,880 (18.2)	744,953/138,788 (18.6)	
n 70–79	326,449/48,849 (15.0)	377,310/56,852 (15.1)	424,024/65,946 (15.6)	473,756/74,733 (15.8)	520,353/83,447 (16.0)	576,801/96,782 (16.8)	636,174/108,235 (17.0)	672,885/121,933 (18.1)	
n ≥ 80	75,436/6,758 (9.0)	92,946/8434 (9.1)	108,600/10,383 (9.6)	127,072/12,619 (9.9)	145,961/14,711 (10.1)	166,065/17,659 (10.6)	188,615/20,578 (10.9)	211,322/25,180 (11.9)	
n Total*	1,655,495 [9.56]/ 237,267 (14.3)	1,817,040 [6.1]/ 260,005 (14.3)	1,979,403 [6.4]/ 311,280 (14.7)	2,138,344 [6.8]/ 311,280 (14.6)	2,287,430 [7.1]/ 339,035 (14.8)	2,455,658 [7.5]/ 377,841 (15.4)	2,590,519 [7.8]/ 399368 (15.4)	2,720,777 [8.0]/ 431,964 (15.9)	

*$P < 0.0001$. *n*, the number of type 2 diabetes/the number of case with diabetic retinopathy. Values in [ ] indicate the prevalence of type 2 diabetes. Values in ( ) indicate the prevalence of diabetic retinopathy.

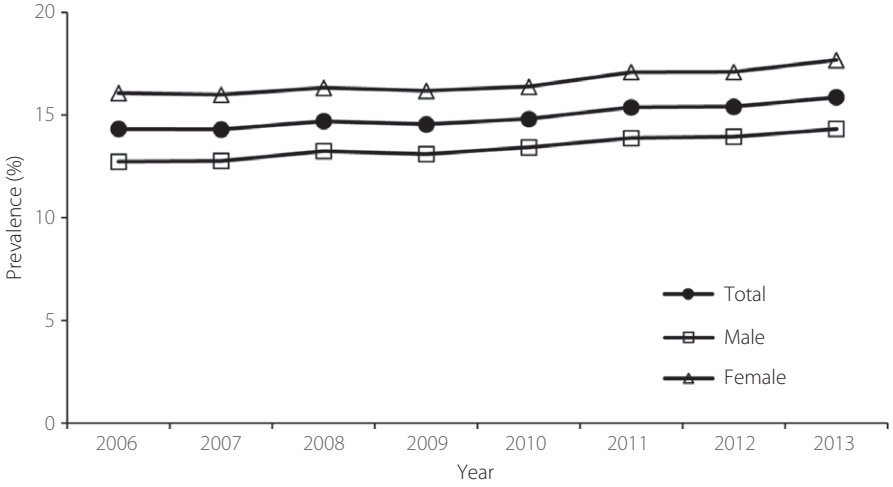

Figure 1 | The prevalence of diabetic retinopathy in 2006–2013, stratified by sex.

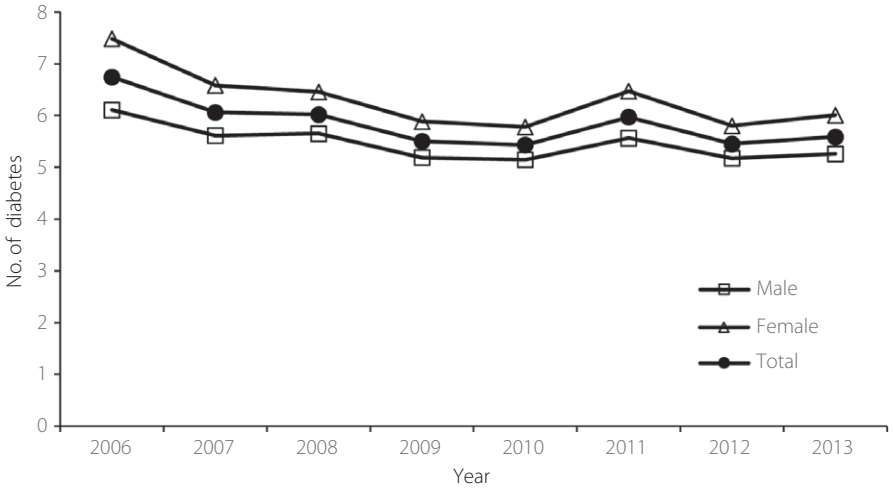

Figure 2 | The incidence rate of diabetic retinopathy in 2006–2013, stratified by sex.

Table 2 | Numbers of diabetes patients and percentage of diabetes patients who received annual dilated fundus examination in 2006–2013

Year	*n*	%
2006	1,655,495	24.34%
2007	1,817,040	24.84%
2008	1,979,403	26.19%
2009	2,138,344	26.63%
2010	2,287,430	27.34%
2011	2,455,658	29.10%
2012	2,590,519	29.06%
2013	2,720,777	30.02%

6.9% received laser treatment, as compared with 11.4 and 2.4%, respectively, in 2006 ($P < 0.0001$). Furthermore, although the prevalence and incidence of DR were higher in female patients with DR, the proportions of patients who received laser treatment (12.6 vs 10.4% in 2006 and 8.2 vs 5.8% in 2013) or vitrectomy (2.6 vs 2.1% in 2006 and 2.0 vs 1.5% in 2013) were higher among men.

Visual impairment in patients with diabetes and DR

Finally, among patients with diabetes and DR, the proportion of patients who had a best-corrected visual acuity of <0.1 decreased from 2.0% (4,820/237,267) in 2006 to 0.8% (3,572/431,964) in 2013 (Table 4).

DISCUSSION

The exponential increase in the prevalence of diabetes in most Asian countries has made DR a national public health issue[12–14]. However, until now, there have been limited studies investigating whether the actual prevalence of DR has been increasing or

Table 3 | Proportions of patients with diabetic retinopathy who received vitrectomy or laser

Year	Diabetic retinopathy (*n*)	Vitrectomy		Laser treatment	
		n	%	*n*	%
2006	237,267	5,594	2.4	27,108	11.4
2007	260,005	5,863	2.3	26,707	10.3
2008	291,181	6,314	2.2	28,268	9.7
2009	311,280	6,510	2.1	28,371	9.1
2010	339,035	6,766	2.0	28,281	7.5
2011	377,841	6,697	1.8	29,543	7.8
2012	399,368	7,008	1.8	29,761	7.5
2013	431,964	7,467	1.7	29,959	6.9

Table 4 | Proportion of patients who had visual impairment among diabetic retinopathy patients

	Total	Visual impairment (*n*)	%
2006	237,267	4,820	2.0
2007	260,005	5,512	2.1
2008	291,181	5,659	1.9
2009	311,280	5,341	1.7
2010	339,035	4,976	1.5
2011	377,841	4,477	1.2
2012	399,368	4,000	1.0
2013	431,964	3,572	0.8

decreasing as a result of earlier diagnosis and improved treatment for diabetes[5–7]. A recent report based on health insurance data from Taiwan showed that the age-adjusted prevalence rates of sight-threatening DR showed decreasing trends for both sexes, with a mean of 2.75% for women and 2.87% for men[4]. In the present study, there was an increase in the number of patients with diabetes, from 1,655,495 (5.6%) in 2006 to 2,720,777 (8.0%) in 2013, and the DR prevalence increased from 237,267 (14.3%) in 2006 to 431,964 (15.9%) in 2013.

The present study revealed two specific factors, namely age and sex, that showed constant trends throughout the study period. First, we observed that the mean age at the development of DR was 60 years, and the highest prevalence of DR was noted in the age group of 60–69 years. This result is in contrast to a previous study carried out in China, which reported that the highest prevalence of DR was observed in the 40–48 years age group[15].

The present study results might represent more generalized results than other studies, as the China study was based on hospitalized patients' data from one hospital. Whether there is a difference in age at the development of DR between Asians requires more investigation.

Second, the present result on the sex distribution among Korean patients with DR showed that female patients with diabetes tended to have a higher prevalence of DR. However, there is the possibility that the prevalence of severe retinopathy that requires treatment is predicted to be higher among men, as the proportions of patients who received laser treatment or vitrectomy were higher among men in the present study. This result is in accordance with other previous studies that sex differences exist among patients with severe DR, with higher rates observed in men[4,16]. However, we could not conclude whether sex is an independent risk factor for DR or not, as we did not include factors such as the diabetes duration or blood glucose level, which might influence the DR prevalence, in our analyses.

Although more than 98% of diabetes patients underwent dilated fundus examinations during the follow-up period, in 2013, just 30% underwent annual dilated fundus examinations. This rate was lower than that recently reported in other countries, where at least 33% of the patients with diabetes underwent annual eye examinations[17–20]. Therefore, greater efforts from diabetes care providers are necessary to improve the continuity of DR screening in the Korean population.

In the present study, the proportion of patients with diabetes who had DR and visual impairment showed a decreasing trend; this result was similar to the results of previous studies[21,22]. However, we cannot conclude whether the number of patients with visual impairment is actually decreasing, because registration with the National Visually Handicapped Registry is not mandatory in Korea, leading to a possibility of underestimation of the number of patients with visual impairment. Nevertheless, whereas the rate of DR-related visual impairments in previous studies was based on self-reported data, the present study results could be considered more accurate, because they were based on the best-corrected visual acuity.

The present study had several limitations. First, although our study was based on the entire Korean population, the prevalence of DR might have been underestimated. As our study was based on medical claims, patients with asymptomatic DR who did not receive recommendations from their doctors for fundus examination were not included in the analysis. Second, the number of patients undergoing laser treatment or vitrectomy for DR might have been overestimated. As aforementioned, as we could not determine the indication for the treatments, it is possible that some patients with DR received laser treatment or underwent vitrectomy for other causes, such as retinal vein occlusions and retinal detachment.

To our knowledge, this is the first report providing clinical information regarding recent trends in the screening rates, treatment patterns and visual impairment among Korean type 2 diabetes patients with DR. The prevalence of DR among type 2 diabetes patients remained low during 2006–2013. It is encouraging to know that new incident cases of DR are decreasing. However, a longer follow-up period and clinical information are required to confirm these findings.

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DISCLOSURE

The authors declare no conflict of interest.

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