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Prevalence of Chronic Complications in Korean Patients with Type 2 Diabetes Mellitus Based on the Korean National Diabetes Program

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Background: The Korean National Diabetes Program (KNDP) cohort study is performing an ongoing large-scale prospective multicenter investigation to discover the pathogenesis of type 2 diabetes in Korean patients. This study was performed to examine the prevalence of chronic complications in patients with type 2 diabetes among those registered in the KNDP cohort within the past 4 years.

Methods: This study was performed between June 2006 and September 2009 at 13 university hospitals and included 4,265 KNDP cohort participants. Among the participants, the crude prevalence of microvascular and macrovascular diseases of those checked for diabetes-related complications was determined, and the adjusted standard prevalence and standardization of the general population prevalence ratio (SPR) was estimated based on the 2005 Korean National Health and Nutrition Examination Survey (KNHANES) population demographics.

Results: Among the KNDP registrants, 43.2% had hypertension, 34.8% had dyslipidemia, 10.8% had macrovascular disease, and 16.7% had microvascular disease. The SPR of the KNDP registrants was significantly higher than that of the KNHANES subjects after adjusting for demographics in the KNHANES 2005 population. However, with the exception of cardiovascular disease in females, the standardized prevalence for the most complicated items in the survey was significantly higher than that in the KNHANES subjects.

Conclusion: The prevalence of macrovascular disease and peripheral vascular disease were significantly higher in Korean patients with type 2 diabetes than in the normal population. However, no significant difference was noted in the prevalence of cardiovascular disease in females.

Keywords: Cerebrovascular disorders; Coronary disease; Diabetes mellitus, type 2; Diabetic retinopathy; Korea

INTRODUCTION

Diabetes is associated with chronic diseases such as hypertension, dyslipidemia, and various other chronic complications including large artery diseases such as coronary artery disease, cerebrovascular disease, and peripheral vascular disease, as well as retinopathy, nephropathy, neuropathy, microvascular disease, autonomic nervous system diseases, skin diseases, and infectious diseases. These diseases are often the direct causes of death in patients with diabetes [1,2].

The prevalence of chronic complications from diabetes is generally thought to be dependent on the duration of diabetes, and the extent and occurrence of chronic complications are strongly associated with the degree of glycemic control. This explains the necessity for intensive glycemic control in patients with diabetes [3-6]. The prevalence of chronic complications from diabetes is increasing, and the mortality rate is also expected to increase significantly [7-9]. However, few systematic studies on chronic complications are available in Korean patients with type 2 diabetes.

A national-scale research project was implemented in May 2005 by the Korean National Diabetes Program (KNDP) to study prevention, treatment, and management of type 2 diabetes in Korean patients. Through the KNDP, researchers are going to establish suitable prevention, diagnostic, and treatment guidelines by studying the characteristics of Korean patients with type 2 diabetes. Clinical epidemiological research, clinical trials led by researchers, and clinical practice guidelines for standards of diabetes are being performed and developed through a specific KNDP project, and a cohort study is currently being conducted in patients with type 2 diabetes and in patients at high risk for developing diabetes. This study was expected to identify the pathophysiology and clinical characteristics of Korean patients at high risk for developing diabetes and those with type 2 diabetes.

This study was conducted between 2005 and 2009 on patients who were registered for the KNDP cohort study based on their baseline clinical data, to confirm the prevalence of chronic complications in Korean patients with type 2 diabetes. In addition, data were compared to the examined prevalence of chronic diseases through the Korean National Health and Nutritional Examination Survey (KNHANES) 2005 to confirm relative risk to the general population.

METHODS

KNDP cohort study

KNDP cohort studies are prospective, multicenter, and observational studies performed on Korean patients with type 2 diabetes and patients at high risk for diabetes. The first patients were enrolled in May 2006, and we are expecting to make primary observations on registered participants until March 2014.

The KNDP cohort was composed of 2 groups, patients with type 2 diabetes and patients at high risk for diabetes. The type 2 diabetes cohort was composed of patients who had satisfied the diagnostic criteria set by the American Diabetes Association in 2004 and who were at least 20 years old [10]. Subjects with impaired fasting glucose or impaired glucose tolerance, as well as subjects who had met the diagnostic criteria for gestational diabetes, were identified as high risk subgroup for diabetes [10].

The KNDP cohort study was performed at the following 13 research hospitals: Kyung Hee University Hospital, Kyung Hee University Hospital at Gangdong, Korea University Guro Hospital, Ajou University Hospital, Inha University Hospital, Hanyang University Guri Hospital, Gachon Medical School Gil Hospital, Pusan National University Hospital, Kwandong University Cheil General Hospital and Women's Healthcare Center, Yeungnam University Medical Center, Inje University Sanggye Baik Hospital, Hallym University Gangdong Sacred Heart Hospital, and the Catholic University of Korea Uijeongbu St. Mary's Hospital. Among these, the Catholic University of Korea Uijeongbu St. Mary's Hospital only worked with the high-risk diabetes cohort, whereas the other 12 hospitals worked with both the diabetes cohort and the high-risk diabetes cohort. Prior to performing the KNDP cohort study, each hospital received approval from the Institutional Review Board, and all participants gave their written consent after receiving a full study summary.

The KNDP cohort clinical data consisted of medical histories, physical examinations, laboratory tests, and surveys. Each survey item was provided as it appeared in the KNDP researcher manual, and surveys were conducted at 6 months, 1 year, and 3 years. The primary outcomes of the KNDP cohort were mortality, diabetes-related microvascular complications, and macrovascular complications. The secondary outcomes were the factors causing diabetes related mortality and complications. The tertiary outcomes were made separately based on the detailed research projects of each hospital that participated

in the KNDP cohort study. The final decisions regarding the complications of study participants were made by the KNDP complications decision committee, which consisted of experts in each field, to ensure objectivity of the diagnoses.

The number of participants in the KNDP diabetes cohort was estimated by means of an exposure factors that affected the primary outcomes of the participants. The rate of occurrence of complications was 5%, relative risk was 1.5%, α was 90%, and power (1-β) was 80% for the expression factor-exposed group and for the sample size of the non-expression group. The sample size of the expression group was assumed to be 0.5, and that at the end of the observations was estimated to be 940 for the expression group (exposed) and 1,880 in the non-expression group, which required approximately 2,820 samples. Assuming that the annual dropout rate was 5%, the estimated number of KNDP cohort subjects was 4,250.

All of the data associated with the KNDP cohort were recorded in the KNDP written case records, and all data were entered, maintained, and managed with active internet-based electronic case report forms (eCRF, http://www.kndp.or.kr) at each of the organized research institutions.

Subjects
Until September 2009, total 4,265 subjects were enrolled in the KNDP diabetes cohort. Among the 4,265 registered KNDP patients that were in the type 2 diabetes cohort, 3,795 had submitted surveys regarding their diabetes-related chronic complications by September 2009. Patients were excluded if they had not completed their medical history survey by September 2009 or if their clinical information had not been registered with the KNDP eCRF.

Methods
During registration of the KNDP diabetes cohort, age, gender, diabetes duration, height, weight, waist circumference, resting blood pressure, and other baseline clinical characteristics were surveyed for all of the subjects, and blood samples were collected to test for fasting plasma glucose, glycated hemoglobin, and serum lipid profiles, as well as other biochemical tests. In addition, hypertension, dyslipidemia and associated diseases, various macrovascular diseases associated with diabetes, and a history of complications from vascular disease were verified through surveys. The investigated macrovascular disease complications were cardiovascular diseases such as myocardial infarction, angina, congestive heart failure, atrial fibrillation, ce-

rebral infarction, transient cerebral ischemia, peripheral arterial disease, amputation, and foot ulcers, as well as a history of percutaneous transluminal coronary angioplasty, a coronary artery bypass graft, or a stent implantation from a cerebrovascular hemorrhage. When the study subjects were unable to identify their cerebrovascular disease, they were classified as "unspecified stroke." In addition, vascular diseases related to major complications of the eyes such as retinopathy, cataracts, glaucoma, history of photocoagulation, retinal surgery, and cataract surgery were evaluated. However, because of the ongoing prospective nature of the study, the KNDP cohort used in this study relied on baseline data and not on recently observed data or new clinical outcomes.

The crude prevalence of diabetes-related complications for macrovascular and microvascular diseases of the participants was calculated based on the baseline medical history of the surveyed participants. However, the survey data from the largest national health survey in Korea, the KNHANES 2005, were used to standardize incidence to directly compare the calculated classification of the organization of the gender and age of subjects registered to the KNDP cohort of the general population to that of the population that participated in this study. In total, 25,215 males and females >15 years old were surveyed in the third phase of the KNHANES 2005, and their chronic disease histories were collected, including hypertension, dyslipidemia, cerebrovascular disease, myocardial infarction, angina, cataracts, or glaucoma. This confirmed the prevalence of diabetes-related chronic diseases based on the findings of the KNDP survey. The adjusted standard prevalence of chronic complications in the KNDP cohort registrants was estimated based on age and gender demographics using the direct standardization method. An indirect standardization method, which is based on the demographics of the Korean population in 2005, was used to estimate the standardized prevalence ratio (SPR) to confirm the comparative risk of complications in the KNDP cohort registrants to that of the general population [11,12].

Analysis
SPSS version 13.0 (SPSS Inc., Chicago, IL, USA) was used to perform the statistical analysis and data management. The descriptive statistics of the clinical variables are expressed as means and standard deviations, and the Student's t and chi-square tests were used to confirm statistical significance between males and females. P values of less than 0.05 were con-

sidered significant.

RESULTS

Participant clinical characteristics

Among the 3,795 participants who were included in the analysis, 2,142 were male and 1,653 were female. The mean age of these individuals was 54.0 years, and the mean diabetes duration was 6.0 years (Table 1). The mean body mass index (BMI) of the participants was 25.1 kg/m^2, mean waist circumference was 87.9 cm, mean fasting plasma glucose was 147.5 mg/dL, and mean glycated hemoglobin was 7.8%.

Significant gender-based differences were observed in many of the surveyed clinical variables (Table 1). Diastolic blood pressure, fasting glucose, glycated hemoglobin, triglycerides, aspartate transaminase, alanine transaminase, and γ-glutamyltransferase were significantly higher in males than in females, and mean age, diabetes duration, BMI, and total cholesterol were relatively higher in females than in males. Significant differences in systolic blood pressure and high sensitivity C-reactive protein concentrations between genders were not observed.

There were significantly more male current smokers, ex-smokers, ex-drinkers, and current drinkers than female ones (Table 1).

Table 1. Baseline characteristics of the study subjects

Characteristic	Male (n=2,142)	Female (n=1,653)	P value	Total (n=3,795)
Age, yr	52.3±10.3	56.3±10.2	<0.001	54.0±10.4
DM duration, yr	5.7±6.2	6.4±6.8	<0.003	6.0±6.5
BMI, kg/m^2	25.0±3.0	25.3±3.5	0.019	25.1±3.2
AC, cm	89.1±7.7	86.3±8.5	<0.001	87.9±8.2
SBP, mm Hg	125.7±14.7	125.5±15.4	0.792	125.6±15.0
DBP, mm Hg	79.0±9.9	77.3±9.7	<0.001	78.3±9.8
FPG, mg/dL	150.5±53.8	143.7±53.9	<0.001	147.5±53.9
HbA1c, %	7.8±2.0	7.7±1.7	0.009	7.8±1.9
TC, mg/dL	178.9±40.6	186.9±41.8	<0.001	182.4±41.3
TG, mg/dL	172.5±139.6	149.6±95.9	<0.001	162.5±123.1
BUN, mg/dL	15.0±4.6	14.4±5.2	<0.001	14.7±4.9
Creatinine, mg/dL	0.9±0.2	0.7±0.3	<0.001	0.84±0.30
AST, IU/L	27.1±21.3	24.6±13.9	<0.001	26.0±18.5
ALT, IU/L	32.8±29.5	25.9±17.6	<0.001	29.7±25.2
γGT, mg/dL	61.2±101.1	30.5±34.9	<0.001	47.7±80.7
hsCRP, mg/dL	1.92±11.81	2.43±16.85	0.446	2.2±14.3
Smoking status (n=3,717)				
Never, n (%)	443 (21.1)	1,514 (93.5)	<0.001	1,957 (52.6)
Ex-smoker, n (%)	899 (42.9)	45 (2.8)		944 (25.4)
Current, n (%)	755 (36.0)	61 (3.7)		816 (22.0)
Alcohol status (n=3,711)				
Never, n (%)	361 (17.2)	1,158 (71.7)	<0.001	1,519 (40.9)
Previous drinker, n (%)	322 (15.4)	105 (6.5)		427 (11.5)
Current drinker, n (%)	1,412 (67.4)	353 (21.8)		1,765 (47.6)

Mean±standard deviation by independent sample t-test and chi-square test.
BMI, body mass index; AC, abdominal circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; FPG, fasting plasma glucose; TC, total cholesterol; TG, triglyceride; BUN, blood urea nitrogen; AST, aspartate aminotransferas; ALT, alanine aminotransferase; hsCRP, high sensitivity C-reactive protein.

Crude prevalence of chronic complications

The crude prevalence of hypertension in all KNDP diabetes cohort subjects was 43.2%, and the crude prevalence of dyslipidemia was 34.8% (Table 2). Some gender-related differences were noted; for example, hypertension and dyslipidemia were significantly more prevalent in females.

The prevalence of macrovascular disease in the KNDP registrants was 10.8% (Table 2). The prevalence of cardiovascular disease, cerebrovascular disease, and peripheral vascular disease in the study subjects was 5.5%, 5.0%, and 1.1%, respectively. The prevalence of a history of myocardial infarction and stent implantation was significantly higher in male than in female patients, although no significant gender-based differences were observed for any other items. The crude prevalence of microvascular disease was 16.7%, and a significant difference was observed between the genders (13.1% in men vs. 21.3% women; Table 2). When each item was examined, the incidences of retinopathy, cataracts, and related surgery history were significantly higher in females than in males, but no significant gender-based differences were observed regarding history of glaucoma or photocoagulation.

Standardized prevalence of chronic complications in the National Health and Nutrition Examination Survey

Among the KNHANES 2005 subjects, the rates of diabetes-related chronic complications in the 25,215 patients that were at least 15 years old were 14.9%, 3.2%, 1.9%, 0.6%, 1.4%, 5.5%, and 0.7% for the presence of a chronic history of hypertension, dyslipidemia, cerebrovascular disease, myocardial infarction, angina, cataracts, and glaucoma, respectively (Table 3). A significant difference was observed between genders in the prevalence of hypertension, angina, cataracts, and glaucoma, which were significantly higher in females.

The adjusted standardized overall prevalence of the KNDP registrants had a tendency to decrease compared to the crude prevalence. The adjusted standardized values for hypertension, dyslipidemia, cerebrovascular disease, myocardial infarction, angina, cataracts, and glaucoma were 27.9%, 22.6%, 3.2%, 1.1%, 1.8%, 7.8%, and 1.3%, respectively (Table 4). However, using an indirect standardized method, the comparative results showed that most of the items that were examined in the KNDP registrants were significantly higher compared to those of the KNHANES subjects, such that prevalence increased by 1.87-fold for hypertension, 1.72-fold for cerebrovascular disease, 1.79-fold for myocardial infarction, 1.42-fold for cataracts,

Table 2. Crude prevalence of type 2 diabetes-related chronic complications in the study subjects

Variable	Male (n=2,142)	Female (n=1,653)	Total (n=3,795)
Comorbidity			
Hypertension[a]	857 (40.0)	782 (47.3)	1,639 (43.2)
Dyslipidemia[a]	699 (32.6)	622 (37.6)	1,321 (34.8)
Macrovascular complication			
Cardiovascular disease			
MI[a]	51 (2.4)	19 (1.1)	70 (1.8)
Angina	58 (2.7)	47 (2.8)	105 (2.8)
HF	9 (0.4)	4 (0.2)	13 (0.3)
Af	4 (0.2)	7 (0.4)	11 (0.3)
PTCA	22 (1.0)	10 (0.6)	32 (0.8)
CABG	5 (0.2)	3 (0.2)	8 (0.2)
Stent[a]	38 (1.8)	10 (0.6)	48 (1.3)
Total	129 (6.0)	79 (4.8)	208 (5.5)
Cerebrovascular disease			
Cb hemorrhage	18 (0.8)	19 (1.1)	37 (1.0)
Cb infarction	66 (3.1)	50 (3.0)	116 (3.1)
TIA	2 (0.1)	6 (0.4)	8 (0.2)
Unspecified stroke	14 (0.7)	18 (1.1)	32 (0.8)
Total	100 (4.7)	90 (5.4)	190 (5.0)
Peripheral			
PAD	16 (0.7)	12 (0.7)	28 (0.7)
Amputation	3 (0.1)	0 (0.0)	3 (0.1)
Foot ulcer	5 (0.2)	6 (0.4)	11 (0.3)
Total	24 (1.1)	18 (1.1)	42 (1.1)
Total macrovascular issues	236 (11.0)	175 (10.6)	411 (10.8)
Microvascular disease			
Retinopathy[a]	124 (5.8)	142 (8.6)	266 (7.0)
Cataract[a]	147 (6.9)	239 (14.5)	386 (10.2)
Glaucoma	30 (1.4)	34 (2.1)	64 (1.7)
Photocoagulation	28 (1.3)	33 (2.0)	61 (1.6)
Retina Op[a]	20 (0.9)	34 (2.1)	54 (1.4)
Cataract Op[a]	73 (3.4)	105 (6.4)	178 (4.7)
Total[a]	280 (13.1)	352 (21.3)	632 (16.7)

Values are presented as number (%).
[a]Statistically significant between males and females by chi-square test (P<0.05).
MI, myocardial infarction; HF, heart failure; Af, atrial fibrillation; PTCA, percutaneous transluminal coronary angioplasty; CABG, coronary artery bypass graft; Cb, cerebral; TIA, transient ischemic attack; PAD, peripheral arterial disease; Op, operation.

Table 3. Prevalence of type 2 diabetes-related complications in the KNHANES 2005 population

Variable	Male (n=11,726)	Female (n=13,489)	Total (n=25,215)
Hypertension[a]	1,666 (14.2)	2,100 (15.6)	3,766 (14.9)
Dyslipidemia	396 (3.4)	405 (3.0)	801 (3.2)
Cerebrovascular disease	238 (2.0)	236 (1.8)	474 (1.9)
MI	84 (0.7)	75 (0.6)	159 (0.6)
Angina[a]	133 (1.1)	230 (1.8)	363 (1.4)
Cataract[a]	469 (4.0)	915 (6.8)	1,384 (5.5)
Glaucoma[a]	64 (0.5)	107 (0.8)	171 (0.7)

Values are presented as number (%).
KNHANES, Korea National Health and Nutrition Examination Survey; MI, myocardial infarction
[a]Statistically significant between males and females by the chi-square test ($P<0.05$).

and 1.94-fold for glaucoma. Dyslipidemia was particularly high, with a 7.10-fold increased prevalence in the KNDP registrants. However, angina in the KNDP registrants was 1.24 times higher than that in the KNHANES participants, although this difference was not statistically significant. When this result was analyzed by gender, the prevalence of all surveyed complications in males was significantly higher in the KNDP cohort registrants than that in the KNHANES subjects. However, no significant differences were observed for cardiovascular complications such as myocardial infarction or angina in females (Table 4).

DISCUSSION

The prevalence of chronic complications due to type 2 diabe-

Table 4. Standardized prevalence of type 2 diabetes-related chronic complications in the study subjects

Disease entity	KNDP cases, No.	Crude prevalence, %	Standardized prevalence, %	SPR[a]	95% CI
Total					
Hypertension	1,639	43.2	27.9	1.87	1.78-1.96
Dyslipidemia	1,321	34.8	22.6	7.10	6.71-7.49
Cerebrovascular disease	190	5.0	3.2	1.72	1.47-1.97
MI	70	1.8	1.1	1.79	1.36-2.22
Angina[b]	105	2.8	1.8	1.24	1.00-1.48
Cataract	386	10.2	7.8	1.42	1.28-1.57
Glaucoma	64	1.7	1.3	1.94	1.46-2.43
Males					
Hypertension	857	40.0	28.0	1.97	1.84-2.11
Dyslipidemia	699	32.6	24.1	7.13	6.59-7.67
Cerebrovascular disease	100	4.7	3.4	1.66	1.33-1.99
MI	51	2.4	1.7	2.36	1.70-3.03
Angina	58	2.7	2.0	1.77	1.31-2.24
Cataract	147	6.9	5.5	1.37	1.15-1.60
Glaucoma	30	1.4	1.2	2.18	1.38-2.97
Females					
Hypertension	782	47.3	27.1	1.74	1.62-1.87
Dyslipidemia	622	37.6	20.1	6.68	6.14-7.21
Cerebrovascular disease	90	5.4	3.0	1.73	1.37-2.10
MI[b]	19	1.2	0.6	1.08	0.58-1.57
Angina[b]	47	2.8	1.6	0.93	0.66-1.20
Cataract	239	14.5	9.8	1.44	1.25-1.63
Glaucoma	34	2.1	1.4	1.77	1.17-2.38

KNDP, Korea National Diabetes Program; SPR, standardized prevalence ratio; CI, confidence interval; MI, myocardial infarction.
[a]Statistically not significant.

tes is affected by the study population, patient characteristics such as age, diabetes duration, and the diagnostic methods used to identify the complication. However, the prevalence of cardiovascular disease, stroke, and retinopathy in Europe and North America range between 10.5% to 30.8%, 4.1% to 12.3%, and approximately 10.6% to 36%, respectively, whereas those in the Asia-Pacific region range from 10.5% to 18.1%, 3.7% to 7.5%, and 32.1% to 35.9%, respectively [13-22]. Although some cross-sectional studies are available on patients who have been admitted to Korean hospitals, the prevalence of cardiovascular disease, stroke, and retinopathy in this study was 7.8%, 8.4%, and 35.2%, respectively [23]. When using the initial KNDP cohort registration data, the results showed that the prevalence of hypertension and dyslipidemia in patients with type 2 diabetes was 43.2% and 34.8%, respectively, whereas those of macrovascular disease and microvascular disease due to complications of the eye were 10.8% and 16.7%, respectively. In addition, in almost all of the chronic complication items, the SPR of the KNDP registrants and the prevalence of chronic complications were both significantly higher in patients with type 2 diabetes than in the general population. The exact statistics for Korean patients with type 2 diabetes regarding the prevalence of chronic complications do not exist, whereas the results from this study accurately reflect the current status of the disease and serve as an objective basis.

In this study, the observation of significant gender-based differences among Korean patients with type 2 diabetes is worth mentioning. First, males had significantly higher fasting plasma glucose, glycated hemoglobin, triglycerides, and other items at baseline, whereas mean age, diabetes duration, and total cholesterol were significantly higher in females than in males. Second, the prevalence of a history of acute myocardial infarction, stent implantation, and other items related to macrovascular complications was significantly higher in males than in females. However, significantly more hypertension, dyslipidemia, chronic diseases, retinopathy, cataracts, and microvascular complications were observed in females than in males. Third, of all items surveyed in the KNDP registrants, the SPR was significantly higher in males than in the general population. Females showed no significant differences in cardiovascular diseases such as angina or myocardial infarction compared to the general population.

These gender-based differences in the baseline clinical characteristics of the KNDP registrants may be the cause of the differences based on diabetes duration and the degree of diabetes management. In other words, these gender-based differences may be due to a simple bias. However, it is necessary to review the high mortality rate of middle-aged men and the possibility of reflecting the actual survival of Korean females. The reason that females who were registered with the KNDP were not significantly different from the general population regarding cardiovascular disease SPR was that mean age, diabetes duration of the recruited patients, and the prevalence of chronic complications were lower than those in registered patients. This was due to the fact that there were many pre-menopausal females that had a relatively low risk of cardiovascular disease. Whether or not current KNDP registrants were menopausal was not examined in detail. However, information related to the occurrence of important risk factors associated with macrovascular complications should be further studied in the future.

There are several limitations to this study. First, although this study was based on data from a prospective cohort study, only the initial registered data were used for the analysis. It was also a cross-sectional study, although additional information other than relative risk on prevalence and the general population was obtained. Second, as this study is part of an ongoing larger study, data were missing due to clinical data that were not collected; thus, a census for the KNDP cohort registrants could not be achieved. Third, because the complication prevalence of patients was determined through medical interviews and not by examination, the results are based on statements made by the registrants, which introduces the possibility of error. Fourth, the results can be interpreted slightly differently, due to the differences in the surveying method or the survey items between the KNDP cohort and KNHANES. In particular, the KNHANES randomly selected participants from the general population, whereas the KNDP cohort study was performed on patients who had been admitted to university hospitals. This may have resulted in excluding patients from the cohort who already had a history of clinically severe cardiovascular disease. Finally, the main medical institutions where the KNDP cohort study was conducted are located in Seoul and the Seoul metropolitan area, and the university hospitals are located around Yeungnam and other locations throughout Korea. These location differences limit how accurately primary and secondary medical institutions reflect the conditions of the admitted patients with diabetes. However, the majority of these limitations can be resolved through observation and by continuously tracking the clinical results of

future KNDP registrants. In the future, trends in the change in prevalence of chronic complications can be confirmed in Korean patients with type 2 diabetes based on the progress of this cohort study, and new incidences of complications can also be estimated. The differences in the occurrence of complications based on treatment method can be verified; thus, it is possible to verify whether the identified gender-related differences are meaningful.

The number of patients with type 2 diabetes is increasing sharply throughout the world and is becoming an increasingly important global health issue [24]. However, not all symptoms associated with diabetes are common in all regions of the world. Many researchers believe that race, genetics, social class, lifestyle, and other factors have complex effects on the pathophysiology of diabetes, resulting in worldwide diversity [25]. In this respect, it is necessary to perform a systematic study to better understand prevention and treatment methods specifically for Korean patients with diabetes. Among all of the diabetes cohort studies that are currently underway in Korea, the most extensive is the KNDP cohort study, which is expected to continuously confirm important clinical characteristics of patients with type 2 diabetes.

CONFLICTS OF INTEREST

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

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KNDP diabetes cohort researchers

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