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***Research paper***

# Correlation between outpatient medical adherence and diabetic complications in patients with type 2 diabetes

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## Abstract

The purpose of this study was to investigate the effect of medication adherence on diabetic complications in 19,317 outpatients aged 30 years or older who were diagnosed with type 2 diabetes mellitus and took oral hypoglycemic agents. Data was analyzed from National Health Insurance Service's standard cohort database from 2002 to 2013. For the incidence of diabetic complications, there was significant difference between insurance type, income level and the higher the age, the higher the incidence. In the Kaplan-Meier survival function, the group with higher medication adherence had higher survival probability for diabetic complications than the group with lower adherence. The analysis on diabetic complications by Cox proportional hazard regression model showed that males have 1.12 times higher risk than females. Therefore, it is expected that diabetic complications can be prevented through careful adherence management and that this study result can be used as basic data for differentiated disease management according to demographic and socioeconomic characteristics.

***Keywords***: *Type 2 Diabetes Mellitus, Medication Adherence, Diabetes Complications, Proportional Hazards Models, Disease Management*

## 1. Introduction

### 1.1. Preceding studies

Diabetes is known as a chronic disease, which is difficult to fully recover and needs lifelong drug treatment and lifestyle management, once diagnosed as a patient (American Diabetes Association, 2006). Diabetes is a disease for which it is very important to prevent and manage complications through the regulation of blood glucose; however, patients' self-management is poor, so chronic complications are caused. According to the result of the sixth National Nutrition Survey published in 2013, the prevalence rate of hypertension in men and women over 30 was 34.2% and 26.9%, respectively, and that of diabetes was 13.6% and 10.3%, respectively (Ministry of Health and Welfare, 2011). In 2003, of the causes of death, diabetes was fourth, and hypertensive diseases, ninth, and in 2012, of the causes of death, diabetes was still fifth, and hypertensive diseases, 10$^{th}$ (Statistics Korea, 2018). Representatively, diabetes directly or indirectly affects various complications such as hypertension, heart diseases, cerebrovascular diseases and kidney diseases, of the chronic diseases, so it is important to national management as well as individual management (Pickup and Williams, 2002). As of 2013, about 8.3% of the world's adult population, approximately 380 million people were diagnosed with diabetes, and the International Diabetes Federation (IDF) expected that the number would increase to approximately 590 million in 25 years (2013). The prevalence rate of diabetes in people over 30 increased from 5.6% in 2006 to 8.0% in 2013(Statistics Korea, 2018). The number of patients hospitalized with diabetes is 351 out of 100,000 in South Korea, ranked second in 25 OECD member countries, which is very high (American Diabetes Association, 2013). Adult diabetes increases the incidence rate of cancer in the pancreas, liver, breast and female genitalia, and the mortality rate as compared to healthy people, and the elderly and postmenopausal female diabetics are exposed to the risk factors of femoral head fracture and osteoporosis-related fracture (Gonnelli et al., 2015; Ryu et al., 2014). Type 2 diabetes is the most common form of diabetes, and as for the causes, obesity, irregular eating habits, physical activity, aging, family history of diabetes, race and the maintenance of high blood sugar during first pregnancy have been presented as risk factors (International Diabetes Federation, 2013). As for other factors, many studies report that lifestyle habits such as smoking and drinking are major risk factors causing diabetes (Jee et al., 2010). Another preceding study noted that doctors continuously maintain relationships with patients and are well aware of the history of diseases, the possibility of the aggravation of diseases and the continuation of outpatient treatment in addition to the patients' health problems, so they can help prevent the sudden aggravation of patients' chronic diseases like diabetes and help them spend medical expenses efficiently (Engelgau et al., 2004; Gill et al., 2003; Yoon et al., 2007). According to the recent studies conducted by the Diabetes Control and Complications Trials (DCCT) and Epidemiology of Diabetes Intervention and Complication (EDIC), the active regulation of blood glucose lowers retinal diseases due to diabetes by 76%; kidney diseases by 50%; nerve diseases by 60%; and cardiovascular diseases by 42%, and the risk rate of death accordingly decreases up to 57% (2008). In addition, in a large scale study conducted with 3,642 people in the U.K., 1% glycated hemoglobin had the effect of lowering the prevalence rate of diabetes by 21%; the mortality rate of diabetes by 21%; the total mortality rate by 14%; myocardial infarction by 14%; stroke by 12%; peripheral neuropathies by 43%; microangiopathy

by 37%; and cataracts by 19% (Stratton et al., 2000). Adherence refers to the degree of a patient's observance of medical advice from a doctor, meaning the method and period of taking medicine, dietary control and the induction of changes in lifestyle. In particular, adherence to the administration of medicine is the most important element in patient care (Hearnshaw and Lindenmeyer, 2006).

### 1.2. Need for research

The prevalence rate of (standardized) diabetes of people over 30 increased from 5.6% in 2006 to 8.0 in 2013, and it was 11.3% in 2016 (Statistics Korea, 2018). Diabetes is a disease for which it is very important to manage blood sugar oneself through taking regular medication. Medication adherence refers to the degree of a patient's observance to medical advice from a doctor, meaning the method and period of taking medicine, dietary control and the induction of changes in lifestyle, and especially, adherence to medicine is the most important element for patient care (Hearnshaw and Lindenmeyer, 2006). Diabetes is a disease for which it is very important to prevent and manage complications through the regulation of blood glucose; however, patients' self-management is poor, so they develop chronic complications. In addition, since it increases with the improvement of social and economic levels, diabetes management becomes more important. Therefore, understanding the relationship between diabetic complications and medical adherence would be helpful to prevent diabetic complications. Therefore, this study was attempted to provide materials for the preventive management of diabetic complications by checking the relationship between outpatient medicine adherence and complications with patients diagnosed with diabetes using the data of the National Health Insurance Service (NHIS).
This study used the data of the entire population because the NHIS has accumulated related data since 2000, and with the recent government 3.0 policy, it was judged that by the disclosure of the data, it would become easier to obtain the data and possible to acquire the most variables for the purpose of research.

### 1.2. Study purpose

This study aims to check the correlation between outpatient medical adherence and diabetic complications in patients with type 2 diabetes, utilizing Health Insurance Service cohort data.

1) To present the statistical results of diabetic complications based on demographic characteristics and socioeconomic status of outpatient with type 2 diabetes;
2) To identify the factors contributing to the occurrence of diabetic complications of outpatient engaged on medical adherence; and
3) To interpret data of the factors contributing to the risk-development of diabetic complications of outpatient on medical adherence.

## 2. Method

### 2.1. Study design

This study is a prospective cohort study to analyze the correlation between medical adherence and diabetic complications for two years immediately after the treatment of diabetes. The study used data from 2004 through the end of 2008 with patients who had treatment of diabetes, of adults over 30 in the Service's sample cohort DB that traced subjects qualified for the National Health Insurance from 2002 through 2013. Demographic characteristics included sex and age, and socioeconomic characteristics included income, insurance classification and health/behavioral characteristics. Drinking, smoking and exercise were corrected as confounding factors. The system of the performance of the study is as shown in Figure 1:

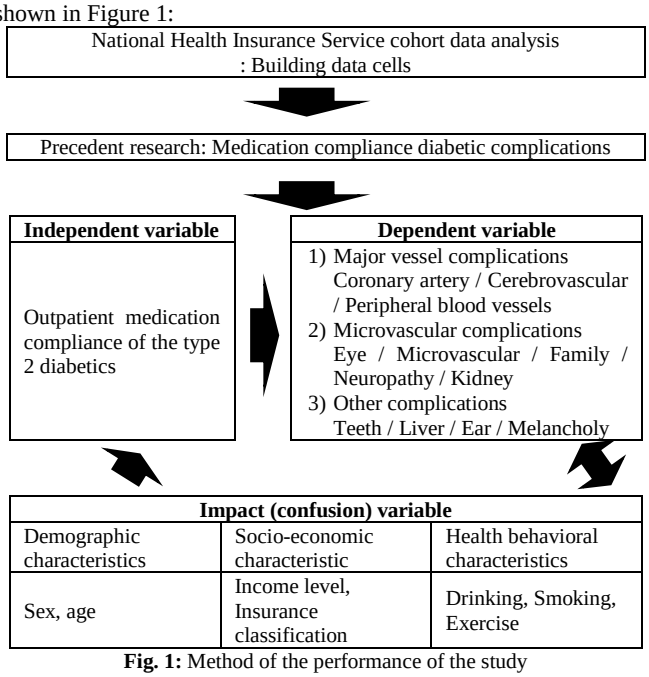


**Fig. 1:** Method of the performance of the study

## 2.2. Setting and sample

According to the International Classification of Disease, 10th Edition (ICD-10), disease codes for diabetes include E10, insulin-dependent diabetes; E11, noninsulin dependent diabetic patient; E12, malnutrition-related diabetes; E13, other specified diabetes; E14, unspecified diabetes; and O24, diabetes in pregnancy, delivery and puerperal period.
To limit the subjects of the study to patients with type 2 diabetes, who have not had complications previously, patients who were diagnosed with type 1 diabetes (E10), diabetes already accompanied by complications (E12-14) and gestational diabetes (O24) were excluded, and outpatients over 30, who had a record of a claim for 92 codes for active compounds of an oral hypoglycaemic agent except for injection medicine, with type 2 diabetes (E11) as the principal or secondary diagnosis were selected as the subjects of the study.
For the search of the preceding studies of the kinds of diabetic complications, this study utilized a total of six databases, including three major domestic academic journals (KISS, Korea Research Information Service and National Science and Technology Information Center), one national library (The National Assembly Library) and two international academic journals (PubMed & Scopus). The period of publication was set from 2000 through December 31, 2017, and as search words, 'diabetic complication' or "complication of diabetes mellitus" were used. From the preceding studies searched by "diabetic complication" and "complication of diabetes mellitus," there were 513 papers in total, including 128 articles in academic journals and 385 theses/dissertations. Of them, excluding 286 papers with repeated contents and 143 papers without any relevance to diabetic complications, finally, 84 papers were selected, and the contents were analyzed.

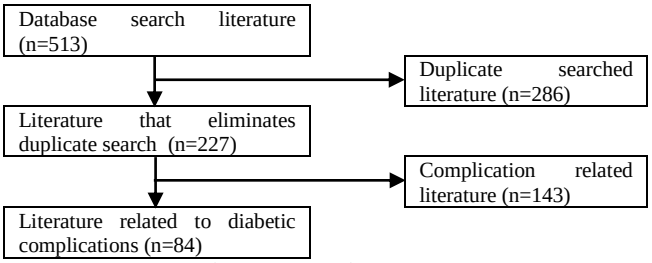


**Fig. 2:** Process of the selection of literature on complications

## 2.3. Data collection

The number of patients who had a record of a claim in the NHIS from 2002 to 2013 in Seoul was 1,125,691 people. The number of outpatients over 30, judged to be diabetic patients since they had a record of a claim for diabetic sign code (E11) or 92 codes of active compounds of diabetic drugs from 2002 through 2012 was 59,900 people, and of them, 34,089 people were classified as new patients with type 2 diabetes, the subjects of an analysis, who had not had any record of a claim for diabetic sign code (E11) or 92 codes of active compounds of diabetic drugs from 2002 through 2003 and had not had diabetic complications before the diagnosis with diabetes.
To secure the period of observation of at least 5 years after diagnosis with diabetes, new diabetic patients after 2009 were excluded, and those who had complications within 2 years after diagnosis with diabetes, too, were excluded since it was very likely that the complications might be caused by factors other than diabetes. Patients who died within 2 years after diagnosis of diabetes were also excluded since they did not meet the period of the assessment of medication adherence, two years. As a result, 19,317 people were selected as the subjects of the study.
Of the final subjects of the study, the subjects were 4,213 people, who had health check-up data to analyze health-behavioural factors.

## 2.4. Definition of variables

As an independent variable, the Medication Possession Ratio (MPR), the total number of days of medication was calculated for two years from the date of the first diagnosis with diabetes in the NHIS outpatient claim data (Hong et al., 2009). MPR>75% was classified as 'good', 50<MPR≦75% as 'average', 25<MPR≦50% as 'insufficient' and MPR≦25% as 'poor' (Hong et al., 2009). The dependent variable, the diabetic complication was judged by whether the subjects of the study had a diagnosis of diabetic complications two years after the date of the first diagnosis of diabetes.

MPR = (Total number of days of medication during the period of research / Period of research (Days)) X 100 (%)

This study divided diabetic complications broadly into three, arterial diseases, microvascular diseases and others through a literature study (Kim et al., 2015). The arterial diseases included coronary artery diseases, cerebrovascular diseases and peripheral vascular diseases; microvascular diseases included eye diseases, foot diseases, neuropathy and kidney diseases; and others, tooth disease, liver disease and depression.
The relevant disease codes of diabetic complications were calculated, based on the quartile code in the 10th International Classification of Disease (ICD-10), and they were checked by consultation of three specialists in the Department of Endocrinology at a tertiary general hospital located in Seoul, two medical insurance review nurses in charge of health insurance review and one professor of insurance review management.

## 2.5. Data analysis

For the statistical analysis of this study, SAS version 9.4 was used, and the level of significance in all analyses was set to 5%.
First, concerning the correlation between the occurrence of diabetic complications and socio-demographic characteristics, a chi-square test was conducted for an analysis.
Second, the correlation between the independent variable, medical adherence and the dependent variable, the occurrence of diabetic complications was analyzed, using Kaplan-Meier survival function and log-rank test.

Third, the impacts of socio-demographic characteristics and medical adherence on the occurrence of diabetic complications were analyzed, using a regression model for Cox proportional hazards.

# 3. Result

## 3.1. Subjects' demographic characteristics and incidence rate of diabetic complications

To examine the general characteristics of the subjects of this study (Table 1), there were a higher percentage of men (55.8%) than women. By age group, most people were in their 50s (27.8%). Those in their 60s and 40s were 26.4% and 20.9%, respectively. Those in their 40s through 60s made up the majority of the subjects (75%).

In the classification of health insurance, workplace subscribers took up the majority (53.6%) while district subscribers were 41.5%. In the income quintiles of the subjects of the study, high income earners at a level higher than 81% were 27.3%. Income earners at a level between 61 and 80% were 21.0%. Medical Care Assistance recipients were the lowest at 5.0%. By MPR, most of them had poor MPR lower than 25% (34.5%), followed by those with good MPR (32.4%), those with average MPR (17.7%) and those with insufficient MPR (15.4%).

**Table 1:** Diabetic complications according to the demographic characteristics of the subjects of the study

| Items | | Complications | | | | | | P-value |
|---|---|---|---|---|---|---|---|---|
| | | Yes | | No | | Total | | |
| | | N | % | N | % | N | % | |
| | | 3,114 | 16.1 | 16,203 | 83.9 | 19,317 | 100.00 | |
| Sex | Men | 1,697 | 15.7 | 9,087 | 84.3 | 10,784 | 55.8 | .1062 |
| | Women | 1,417 | 16.6 | 7,116 | 83.4 | 8,533 | 44.2 | |
| Age | 30s | 136 | 8.8 | 1,403 | 91.2 | 1,539 | 8.0 | <.0001 |
| | 40s | 444 | 11.0 | 3,585 | 89.0 | 4,029 | 20.9 | |
| | 50s | 747 | 13.9 | 4,618 | 86.1 | 5,365 | 27.8 | |
| | 60s | 973 | 19.1 | 4,122 | 80.9 | 5,095 | 26.4 | |
| | 70s | 688 | 25.0 | 2,063 | 75.0 | 2,751 | 14.2 | |
| | Over 80s | 126 | 23.4 | 412 | 76.6 | 538 | 2.8 | |
| Insurance | Regional | 1,340 | 16.7 | 6,667 | 83.3 | 8,007 | 41.5 | .0003 |
| | Work | 1,584 | 15.3 | 8,761 | 84.7 | 10,345 | 53.6 | |
| | Medicare | 190 | 19.7 | 775 | 80.3 | 965 | 5.0 | |
| Income quintile | 0% | 190 | 19.7 | 775 | 80.3 | 965 | 5.0 | .0035 |
| | 1-20% | 490 | 17.1 | 2,382 | 82.9 | 2,872 | 14.9 | |
| | 21-40% | 443 | 16.0 | 2,324 | 84.0 | 2,767 | 14.3 | |
| | 41-60% | 494 | 14.6 | 2,900 | 85.4 | 3,394 | 17.6 | |
| | 61-80% | 639 | 15.8 | 3,411 | 84.2 | 4,050 | 21.0 | |
| | 81-100% | 858 | 16.3 | 4,411 | 83.7 | 5,269 | 27.3 | |
| MPR | Bad | 1,122 | 16.9 | 5,537 | 83.2 | 6,659 | 34.5 | <.0001 |
| | Inadequate | 540 | 18.1 | 2,443 | 81.9 | 2,983 | 15.4 | |
| | Average | 568 | 16.6 | 2,848 | 83.4 | 3,416 | 17.7 | |
| | Great | 884 | 14.1 | 5,375 | 85.9 | 6,259 | 32.4 | |

*N*= number of outpatient

## 3.2. Medical adherence according to the characteristics of the subjects of the study

To examine the level of medical adherence according to the subjects of this study (Table 2), by sex, the ratio of women with good MPR was 33.5%, higher than that of men (31.6%) while that of women with poor MPR was 34.1%, lower than that of men (34.8%) (P=.0021). As for the ratio of people with good MPR by age, that of those in their 60s was the highest at 36.8%, followed by 34.5% in those in their 50s, 30.0% of those in their 70s and 29.6% in those in their 40s. That of those over 80 and those in their 30s was relatively low at 25.8% and 24.5%, respectively. As for the ratio of people with poor MPR by age, that of those over 80 was 45.7%, and that of those in their 70s was 41.1%, highest in the old age groups, followed by those in their 30s at 39.8%, and those in their 40s, 50s and 60s, 34.8%, 30.6% and 32.0%, respectively (P<.0001). In case of low age, medical adherence would be low because it is not active to take medication with confidence in health. As for the ratio of people with good MPR by insurance classification, that of workplace subscribers took up 35.5%, that of district subscribers was 32.3%, and that of Medical Care Assistance recipients was very low at 0.2%. As for the ratio of people with poor MPR according to insurance classification, that of district subscribers was 32.1%, and that of workplace subscribers were 30.7%. That of Medical Care Assistance recipients was very high at 94.9% (P<.0001).

As for the ratio of people with good MPR by income quintile, the group of income quintile 81-100% was 36.2%, the highest, followed by that of income quintile between 61 and 80% (34.8%), that of income quintile between 41 and 60% (32.9%), that of income quintile between 21 and 40% (32.2%), that of income quintile between 1-20% (32.4%). It turned out that the lower the income quintile, the lower the ratio of people with good MPR became. The ratio of people with good MPR was very low at 0.2% in the group of 0 quintiles, medical aid beneficiaries (P<.0001).

**Table 2:** Medical adherence according to the demographic characteristics of the subjects of the study

| Items | | MPR level | | | | | P-value |
|---|---|---|---|---|---|---|---|
| | | Bad (N = 6,659, 34.47%) | Inadequate (N = 2,983, 29.83%) | Average (N = 3,416, 17.68%) | Great (N = 6,259, 32.40%) | Total (N=19,317, 100.00%) | |
| | | 6,659 (34.47) | 2,983 (29.83 | 3,416 (17.68) | 6,259 (32.40 | 19,317 (100.00) | |
| Sex | Men | 3,749 (34.8) | 1,743 (16.2) | 1,890 (17.5) | 3,402 (31.6) | 10,784 (55.8) | .0021 |
| | Women | 2,910 (34.1) | 1,240 (14.5) | 1,526 (17.9) | 2,857 (33.5) | 8,533 (44.2) | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Age | 30s | 612 (39.8) | 280 (17.5) | 270 (17.5) | 377 (24.5) | 1,539 (8.0) | <.0001 |
| | 40s | 1,402 (34.8) | 664 (19.1) | 770 (19.1) | 1,193 (29.6) | 4,029 (20.9) | |
| | 50s | 1,639 (30.6) | 888 (18.4) | 985 (18.4) | 1,853 (34.5) | 5,365 (27.8) | |
| | 60s | 1,630 (32.0) | 712 (17.3) | 880 (17.3) | 1,873 (36.8) | 5,095 (26.4) | |
| | 70s | 1,130 (41.1) | 368 (15.6) | 429 (15.6) | 824 (30.0) | 2,751 (14.2) | |
| | Over 80s | 246 (45.7) | 71 (15.2) | 82 (15.2) | 139 (25.8) | 538 (2.8) | |
| Insurance | Regional | 2,572 (32.1) | 1,332 (16.6) | 1,520 (19.0) | 2,583 (32.3) | 8,007 (41.5) | <.0001 |
| | Work | 3,171 (30.7) | 1,624 (15.7) | 1,876 (18.1) | 3,674 (35.5) | 10,345 (53.6) | |
| | Medicare | 916 (94.9) | 27 (2.8) | 20 (2.1) | 2 (0.2) | 965 (5.0) | |
| Income range | 0% | 916 (94.9) | 27 (2.8) | 20 (2.1) | 2 (0.2) | 965 (5.0) | <.0001 |
| | 1-20% | 908 (31.6) | 479 (16.7) | 556 (19.4) | 929 (32.4) | 2,872 (14.9) | |
| | 21-40% | 849 (30.7) | 467 (16.9) | 560 (20.2) | 891 (32.2) | 2,767 (14.3) | |
| | 41-60% | 1,096 (32.3) | 565 (16.7) | 615 (18.1) | 1,118 (32.9) | 3,394 (17.6) | |
| | 61-80% | 1,252 (30.9) | 654 (16.2) | 733 (18.1) | 1,411 (34.8) | 4,050 (21.0) | |
| | 81-100% | 1,638 (31.1) | 791 (15.0) | 932 (17.7) | 1,908 (36.2) | 5,269 (27.3) | |

*N*= number of outpatient

### 3.3. Survival function analysis of the occurrence of diabetic complications

To examine diabetic complication survival function according to MPR in the subjects of the study (Figure 3), regardless of the level of MPR, the probability of the occurrence of diabetic complications gradually increased in all groups of people with good, average, insufficient and poor MPR as time passed, but the group of those with insufficient MPR came to have the highest probability of the occurrence of diabetic complications. In addition, also in the group of people with poor MPR, the probability of the occurrence of diabetic complications increased as compared to the groups of those with average or good MPR as time passed. Thus the lower the level of MPR, the higher the probability of the occurrence of diabetic complications was maintained a little high (P<.0001).

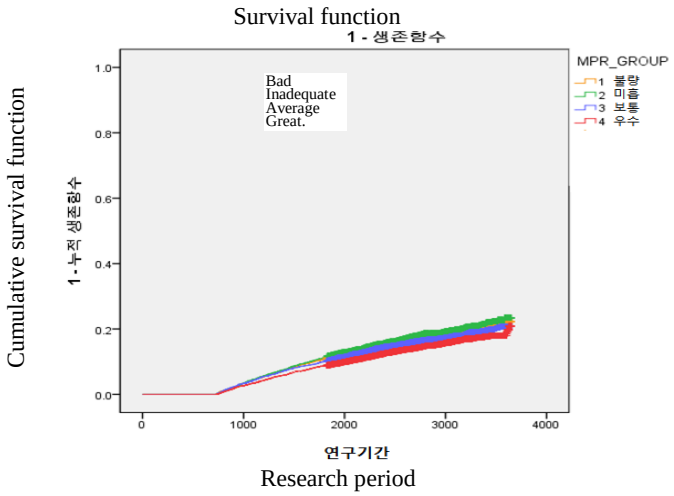


**Fig. 3:** Diabetic complication survival function according to**medical adherence**

To examine diabetic complication survival function by age (Figure 4), the probability of the occurrence of diabetic complications in all age groups increased as time passed; however, the slope by age group, it increased most sharply in people in their 70s. Next, the slope was most gentle in those in their 80s, followed by those in their 60s, 50s, 40s and 30s. The younger the subject, the gentler the slope became. A difference in the probability of the occurrence about 15% occurred in those in their 70s and 30s at the point of the completion of the analysis (P<.0001).

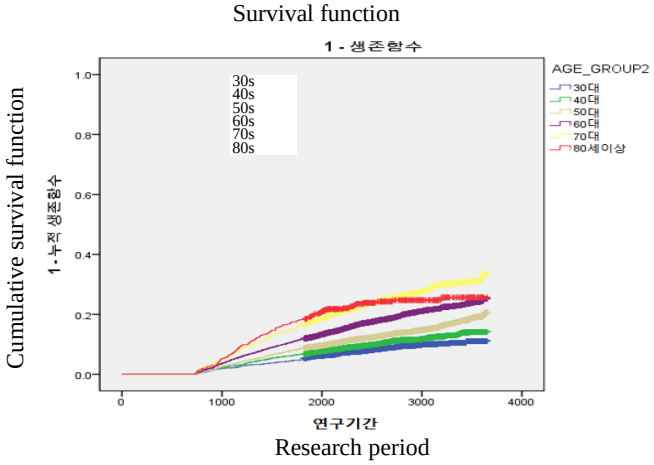


**Fig. 4:** Diabetic complication survival function by age

### 3.4. Analysis of a regression model of Cox proportional hazards concerning the occurrence of diabetic complications

This study analyzed the risk of the occurrence of diabetic complications according to the characteristics of the subjects of the study, with a regression model of Cox proportional hazards (Table 3), and by sex, men had 1.12, 12% higher than that of women (P=.0023). By age group, as compared to people over 80, those in their 70s had a high risk at 1.04 (P=.0023), but it remarkably decreased in the lower age groups with 0.75 (P<.0001) in those in their 60s, 0.52 (P<.0001) in those in their 50s, 0.39 (P<.0001) in those in their 40s and 0.31 (P<.0001) in those in their 30s. By insurance classification, as compared to Medical Care Assistant recipients, workplace subscribers had a lower rate of risk at 0.77 (P<.001), and district subscribers at 0.79 (P=.0075) (P<.0001). By income quintiles, as compared to the top 81-100%, the group of people at the quintile 61-80% had a risk of 1.04 (P=.4601); that of those at the quintile of 41-60%, 0.97 (P=.5673); that of those at the quintile of 21-40%, 1.07 (P=.2605); that of those at the quintile of 1-20%, 1.09 (P=.1249). The lower the income level, the higher rate of risk tended to become, but none were statistically significant. By the classification of MPR, as compared to the group of people with good MPR, that of those with average MPR had a rate of risk 1.17 (P=.0033); that of those with insufficient MPR; 1.32 (P<.0001); and that of those with poor MPR, 1.17 (P=.0006). The lower the level of MPR, the higher rate of risk became.

**Table 3:** Cox proportional hazard regression model for the occurrence of diabetic complications

| Items | | Cox proportional hazards regression model | |
|---|---|---|---|
| | | Hazard Ratio | 95% CI |
| Sex | Men | 1.12 | 1.04-1.20 |
| | Women | 1.00 | |
| Age | 30s | 0.31 | 0.24-0.40 |
| | 40s | 0.39 | 0.32-0.48 |
| | 50s | 0.52 | 0.43-0.62 |
| | 60s | 0.75 | 0.62-0.90 |
| | 70s | 1.04 | 0.86-1.26 |
| | Over 80s | 1.00 | |
| Insurance | Regional | 0.79 | 0.67-0.94 |
| | Work | 0.70 | 0.59-0.83 |
| | Medicare | 1.00 | |
| Income range | 0% | - | - |
| | 1-20% | 1.09 | 0.98-1.22 |
| | 21-40% | 1.07 | 0.95-1.20 |
| | 41-60% | 0.97 | 0.87-1.08 |
| | 61-80% | 1.04 | 0.94-1.15 |
| | 81-100% | 1.00 | |
| MPR | Bad | 1.17 | 1.07-1.29 |
| | Inadequate | 1.32 | 1.18-1.47 |
| | Average | 1.17 | 1.05-1.30 |
| | Great | 1.00 | |

*N*= number of outpatient

## 4. Discussion

As a similar preceding study conducted in South Korea, Kim et al. (2015) noted that the complications of diabetic patients, not hospitalized occurred in 27.4%, and Yoon et al. (2007) noted that there was high medical adherence with more prescriptions for more than 360 days in over 30%. In Hong et al. (2009), the ratio of the optimal medical adherence MPR≧80 was 29.4%. The ratio of the optimal medical adherence in women at 33.7% was higher than 26.8% in men. In addition, according to a study conducted in the U.S., the older the subject, the higher the medical adherence became (Rolnick et al., 2013). In the present study, the number of patients who had a diabetic complication after the first diagnosis with diabetes was 3,114 people out of 19,317 (16.1%). 1,697 people (15.7%) were men, and 1,417 people (16.7%) were women, and the incidence rate was a little higher in women. In this study, complications in diabetic patients, not hospitalized were more than about 10% lower than the complications in the preceding study like Kim et al. (2008).

6,259 people had good medical adherence (MPR≧75) (32.40%); 3,416, average medical adherence (50≦MPR<75) (17.7%); 2,983, insufficient medical adherence (25≦MPR<50) (29.8%); and 6,659, poor medical adherence (0≦MPR<25) (34.5%). Of them, the number of men with good medical adherence was 3,302 (31.6%), and that of women, 2,857 (33.5%). In Kim et al. (2015), there was high medical adherence (about 30%) with more than 360 days of prescription, and the result was similar to that of this study. In Hong et al. (2009), the ratio of optimal medical adherence MPR≧80 was 29.4%. It was 26.8% in men and 33.7% in women, and the ratio of the optimal medical adherence was higher in women. The ratio of good medical adherence by age increased to 24.5% in people in their 30s; 29.6% in those in their 40s; 34.5% in those in their 50s; and 36.8% in those in their 60s. However, it was 30.0% in those in their 70s and 25.8% in those over 80, so there was a rather decreasing tendency in the ratio of good medical adherence. According to a study conducted in the U.S., the older the subject, the higher the medical adherence became, which shows a result similar to that of this study (Rolnick et al., 2013). Likewise, in another domestic study, in the age group between 65 and 74, the older the subject, the higher the ratio of the optimal medical adherence increased, but it decreased in the age groups over that (Hong et al., 2009). Therefore, it is necessary to analyze the cause for the decrease of the ratio of the optimal medical adherence in the elderly over 70s and prepare a measure for increasing the ratio. Concerning the lower ratio of the optimal medical adherence of men as compared to women, it is necessary to make an effort, e.g. providing a reminder for taking medicine by cell phone, so that men busy can manage their medication well.

In this study, the ratio of good medical adherence was 36.2% in people with the highest income quintile 81-100%, which was higher than 34.8% in those with the income quintile of 61-80%; 32.9% in those with the income quintile of 41-60%; 32.2% in those with the income quintile of 21-40%; 32.4% in those with the income quintile of 1-20%; and 0.2% in those with the quintile of 0, Medical Care Assistant recipients, so the result was the same as that of a study in which those in high income brackets had higher medical adherence (Rolnick et al., 2013). The ratio of good medical adherence according to the type of health insurance was highest in workplace subscribers at 35.5%, followed by 32.3% in district subscribers and 0.2% in Medical Care Assistant recipients. In another domestic study (Hong et al., 2009), too, the ratio of the optimal medical adherence was higher in health insurance subscribers than in medical aid beneficiaries, and the odds

at which health insurance subscribes would have optimal medical adherence were 1.53 times higher (CI: 1.14-1.27) than Medical Care Assistant recipients. Medical Care Assistant recipients are people who belong to the income bracket of the quintile 0, and it is judged that they have low medical adherence since their economic level is lower than that of health insurance subscribers. Therefore, it is expected that the results of this study will be utilized as the basic data for the government's policy on chronic patients like those with diabetes.

## 5. Conclusion

According to the results of this study, the ratio of people with good medical adherence (MPR>75) was about 30% in both men and women, and a considerable number of diabetic patients did not carry out medication actively. By age group, based on people in their 70s, the younger the subject, the lower the incidence rate of diabetic complications became, so it is expected that it would be necessary to manage diabetic complications intensively for an aging population. It was found that workplace subscribers who have a stable job had a lower incidence rate of complications than district subscribers or Medical Care Assistant recipients.

With the degree of risk of diabetic complications of the group of people with good medical adherence (MPR>75) as 1.00, that of those with average medical adherence was 1.17% (P=.0033); that of those with insufficient MPR, 1.32% (P<.0001); and that of those with poor MPR, 1.17% (P=.0006). The lower the level of medication adherence, the higher the risk became.

This study assessed the impact of the demographic characteristics and medical adherence of the subjects of the study on diabetic complications, but it did not include the result of differences in incidence rate by region, so it does not include all factors actually affecting diabetic complications. In addition, it is necessary to consider that the impact on diabetic complications may differ depending on the type of drugs even in the same medical adherence. Thus, suggestions are made as follows:

First, it is expected that a follow-up study will be conducted on differences in the incidence rate of diabetic complications by the district and the type of medical institution.

Second, a follow-up study is proposed to investigate the correlation between medication adherence and diabetic complications by the classification of diabetic complications (Arterial diseases, microvascular diseases and other diseases), too.

Third, a follow-up study is proposed to investigate the correlation between medication adherence and diabetic complications by the type of antidiabetic drugs.

Fourth, it is suggested that the correlation between accompanying diseases such as hypertension and dyslipidemia and diabetic complications should additionally be assessed.

This study made an effort to differentiate itself from other studies in that it produced data by dividing diabetes drugs with the code of active compounds and produced data, using ICD-10 Code by disease for three categories that classified diabetic complications broadly into arterial diseases, microvascular diseases and other diseases.

Diabetes is a chronic disease, and through the thorough management of medication adherence and the improvement of one's lifestyle, diabetic complications can be prevented. It is necessary to maintain a lifestyle of restraining from drinking and smoking and manage diabetes in the direction of increasing the quality of life, using an appropriate method of exercise that can strengthen cardiopulmonary endurance and muscular strength rather than focusing on the number of times or length of workouts.

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