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Original Article

The Effect of Hypertension, Diabetes, and Hyperlipidemia on Medication Intake and Adherence: Analysis from Korean Health Panel Survey 2014-2017

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Abstract

Background: Hypertension, diabetes, and hyperlipidemia are common chronic diseases in South Korea, and medication is a key factor in managing these diseases and preventing disease advancement to multimorbidity. This study aimed to evaluate the effect of chronic disease on medication intake and adherence among Koreans.

Methods: This study was conducted utilizing data collected from 5,529 individuals that participated in the Korea Health Panel Survey (KHPS) in 2014-2017. The dependent variables were medication intake and adherence, and independent variables included socioeconomic status and the type of chronic disease. The differences in the medication intake and medication adherence by sociodemographic variables and the type of chronic disease were analyzed by chi-square test. The effect of hypertension, diabetes, and hyperlipidemia on medication intake and adherence was analyzed via multiple logistic regression using SAS statistical software.

Results: The rate of medication intake and adherence were significantly different among patients with hypertension, diabetes, and hyperlipidemia, especially lower in patients with hyperlipidemia compared to those with hypertension and diabetes. In multiple logistic regression analysis, the probability of medication intake increased in female gender, older age, medical aid, medication adherence was higher in married, lower educational level and lower household income. Compared to hyperlipidemia, patients with hypertension and diabetes had more likely to take medication as prescribed.

Conclusion: The importance of considering the type of chronic disease in developing and implementing public health programs aiming for improved medication adherence. Targeting better medication intake and adherence for each chronic disease could be a valuable policy strategy to effectively manage chronic diseases as well as prevent their complications.

Keywords: Chronic disease; Medication adherence; Hypertension; Diabetes mellitus; Hyperlipidemia

Introduction

As the prevalence of chronic diseases continues to rise, chronic diseases place a significant financial and medical burden on health care in South Korea and worldwide as well (1-5). Chronic dis-

ease accounts for more than 80% of health care spending, and the most common diagnoses of primary care practice were hyperlipidemia and hypertension in the United States (6, 7). In South Korea, the total annual economic burden of chronic diseases is estimated to be $25.4billion; hypertension was the most prevalent condition among adults ≥30 yr (33.3%), followed by hyperlipidemia (23.8%) and diabetes (12.4%) (8).

These three conditions are associated with a high risk of cardiovascular disease (CVD), which is one of the leading causes of death in South Korea (9). During the pandemic of COVID-19, people with chronic disease are more vulnerable to complications upon infection with a virus. U.S. Centers for Disease Control and Prevention (CDC) has announced that adults with diabetes mellitus and/or hypertension might be at an increased risk for severe illness from the virus that causes COVID-19 (10). Some diabetic patients with certain conditions would be associated with a higher risk of acquiring COVID-19 (11).

Most chronic diseases are increased from none to one, then single condition is often advanced as multimorbidity if uncontrolled. The presence of hypertension, diabetes and hyperlipidemia frequently coexisted; any form of two or more of these conditions are found within a person. Approximately 59.6% of U.S. adults had multiple (≥2) chronic conditions, and 40% of 40-year-old Koreans having at least two chronic diseases, including hypertension, diabetes, or dyslipidemia (12, 13).

The desirable therapeutic outcomes of chronic disease are achieved by medication intake, however, one-half of patients do not take their chronic disease medications as prescribed (14). Even worse, a barrier towards optimal drug treatment of chronic disease is poor medication adherence. The association among increased medication adherence, improved health outcomes, and lower healthcare costs is well known (15, 16). On the contrary, medication non-adherence can compromise the effectiveness of medication therapies; a single condition might be aggravated more complicated (17, 18).

To date, there have been numerous studies that medication issues are relevant in patients with a specific condition or multiple conditions. Studies of hypertension medications have found that non-adherence is a major obstacle to adequate blood pressure control (19). Medication non-adherence is prevalent among patients with diabetes mellitus and associated with adverse outcomes (20). The 31% of older patients with multimorbidity were non-adherent to their medication; adherence levels varied across chronic conditions (21).

Even though the majority of studies evaluated the medication intake and adherence effect on chronic disease, they generally overlook medication issues in caring for single morbidity that might prevent the development of multimorbidity. Since the course of each chronic disease and the mode of complications caused by each condition are different, understanding the differences in the medication intake and adherence by the type of chronic disease is important. Few studies have explored the comparison of the type of chronic condition for medication intake and adherence, to our knowledge. This study, therefore, aimed to investigate the impact of the type of chronic disease, including hypertension, diabetes, and hyperlipidemia, on medication intake and adherence. This helps to assess whether the specific chronic disease itself has any potential impact on medication intake and adherence. Additionally, it will provide public health strategy which could be helpful to prioritize and implement effective chronic disease management.

Materials and Methods

Sources of data

We obtained data from the Korean Health Panel Survey (KHPS), conducted by Korea Institute for Health and Social Affair and National Health Insurance Service (22). The KHPS is a survey of nationally representative Koreans aged 20 yr and older. The KHP uses stratified multistage probability sampling according to 17 administrative districts of South Korea in order to select na-

tionwide subjects from the 2016 Korean Census. The sample size was determined as a minimum for health statistics assuming a 4.5% margin of error and 95% confidence intervals. The average sample size for each of the 17 administrative districts was about 500 households, eventually, 8,500 households and their members were included KHPS sample. The KHPS data includes information on demographic and socio-economic characteristics, chronic conditions, and status of medication, including intake and adherence. For this study, we decided to use the data from 2014 to 2017 because it included structured questions that determine the prevalence of chronic disease and medication status objectively.

The panel from 2014 to 2017 consisted of 581,967 participants, the number of target population was 5,538 who had a single condition, either hypertension, diabetes, or hyperlipidemia. From 5,538 individuals, 9 individuals without information on medication intake and adherence were excluded. Thus, our analysis included 5,529 individuals; the number of individuals in hypertension, diabetes, and hyperlipidemia were 3,789; 759; and 981; respectively.

Definition of major variables

The main independent variable included the type of chronic disease, and we selected hypertension, diabetes and hyperlipidemia. These diseases were selected on the basis of the most prevalent in South Korea, in which self-management through adherence of medication was emphasized. Hypertension, diabetes, and hyperlipidemia were respectively identified based on International Classification of Disease 10 codes (ICD-10 codes). Specific ICD-10 codes were the following: I10-I15 for hypertension; E10 to E14 for diabetes; and E78 for hyperlipidemia. We also included demographic and socio-economic characteristics such as sex, age, marital status, educational level, medical coverage, disability, economic activity, residential area, and household income. The dependent variables for the current study were medication intake and adherence, measured by binary variables.

Statistics

The baseline differences in the medication intake and medication adherence were calculated by descriptive analysis, and the differences in the distribution of sociodemographic variables and the type of chronic disease were determined by chi-square test. In order to examine the associations between the type of chronic disease and medication intake and medication adherence, multiple logistic regression models were applied. The statistical model equations were as follows:

Medication intake multiple logistic regression equation

$$\log\left(\frac{p(X)}{1-p(X)}\right) = \beta_0 + \beta_1 S + \beta_2 A + \beta_3 Ms + \beta_4 El + \beta_5 Mc + \beta_6 D + \beta_7 Ea + \beta_8 Ra + \beta_9 Hi + \beta_{10} TD$$

$p(X)$: Medication intake, S: Sex, A: Age, Ms: Marital status, El: Educational level, Mc: Medical Coverage, D: Disability, Ea: Economic activity, Ra: Residential area, Hi: Household income, TD: Household income, TD: Type of disease

Medication adherence multiple logistic regression equation

$$\log\left(\frac{p(X)}{1-p(X)}\right) = \beta_0 + \beta_1 S + \beta_2 A + \beta_3 Ms + \beta_4 El + \beta_5 Mc + \beta_6 D + \beta_7 Ea + \beta_8 Ra + \beta_9 Hi + \beta_{10} TD$$

$p(X)$: Medication adherence, S: Sex, A: Age, Ms: Marital status, El: Educational level, Mc: Medical Coverage, D: Disability, Ea: Economic activity, Ra: Residential area, Hi: Household income, TD: Household income, TD: Type of disease

Results are given as odds ratios (ORs) and 95% confidence intervals (95% CIs). All statistical analyses were performed using SAS version 9.4 (SAS Institute, Inc., Cary, NC, USA), a 2 tailed *P*-values ≤ 0.05 were deemed statistically significant.

Results

Table 1 presents the results for the prevalence of each condition by general characteristics. There were 3,789 total of hypertension, 759 of diabetes

and 981 of hyperlipidemia, respectively. Among those, the prevalence of hypertension and diabetes was higher in males, and females occupied 60.9% in hyperlipidemia. As for age groups, people over 60 yr were the majority (60.4%) in hypertension. By household income presented in the quintile (Q1 (lowest), Q2, Q3, Q4, or Q5 (highest), the prevalence of hypertension was relatively lower in Q4 (17.7%) followed by Q5 (18.8%), and hyperlipidemia was the lowest in Q1 (11.5%).

Table 1: General characteristics and the prevalence of chronic diseases

Variable	*Total (N=5,529)*		*Hypertension (N=3,789)*		*Diabetes (N=759)*		*Hyperlipidemia (N=981)*	
	N	%	N	%	N	%	N	%
Sex								
Male	3,149	57.0	2,257	59.6	508	66.9	384	39.1
Female	2,380	43.0	1,532	40.4	251	33.1	597	60.9
Age (yr)								
20-39	167	3.0	105	2.8	36	4.7	26	2.6
40-59	2,284	41.3	1,397	36.9	384	50.6	503	51.3
60+	3,078	55.7	2,287	60.3	339	44.7	452	46.1
Marital status								
Married	4,469	80.8	3,009	79.4	621	81.8	839	85.5
Unmarried/Divorced/Widowed	1,060	19.2	780	20.6	138	18.2	142	14.5
Educational level								
Elementary school or below	1,383	25.0	1,070	28.2	158	20.8	155	15.8
Middle-to-High school	2,783	50.3	1,839	48.6	411	54.2	533	54.3
College or above	1,363	24.7	880	23.2	190	25.0	293	29.9
Medical Coverage								
National Health Insurance	5,354	96.8	3,666	96.8	732	96.4	956	97.5
Medical aid	175	3.2	123	3.2	27	3.6	25	2.5
Disability								
Non-disabled	5,099	92.2	3,463	91.4	704	92.8	932	95.0
Disabled	430	7.8	326	8.6	55	7.2	49	5.0
Economic activity								
Participation	3,389	61.3	2,300	60.7	489	64.4	600	61.2
Non-participation	2,140	38.7	1,489	39.3	270	35.6	381	38.8
Residential area								
Metropolitan	2,408	43.6	1,573	41.5	356	46.9	479	48.8
Rural	3,121	56.4	2,216	58.5	403	53.1	502	51.2
Household income								
Q1 (lowest)	1,000	18.1	772	20.4	115	15.2	113	11.5
Q2	1,137	20.5	823	21.7	149	19.6	165	16.8
Q3	1,210	21.9	809	21.4	182	24.0	219	22.3
Q4	1,050	19.0	672	17.7	142	18.7	236	24.1
Q5 (highest)	1,132	20.5	713	18.8	171	22.5	248	25.3

Comparison in medication intake and adherence by the type of chronic disease

The extent of patients' medication intake and adherence by type of chronic disease is depicted in Table 2. Medication intake rates were estimated to be 92.0% for hypertension, 89.9% for diabetes, and 66.2% for hyperlipidemia. Of these, 91.7% of hypertension, 92.1% of diabetes, and

86.4% of hyperlipidemia were adherent to medication. Both medication intake and adherence were significantly lower in participants with hyperlipidemia compared to those with hypertension and diabetes.

Table 2: Comparison in medication intake and adherence by the type of chronic disease

Variable	*Medication intake*							*Medication adherence*						
	Total		Yes		No		*P*-value	Total		Yes		No		*P*-value
	N	%	N	%	N	%		N	%	N	%	N	%	
Hypertension	3,789	100.0	3,486	92.0	303	8.0	0.000	3,486	100.0	3,198	91.7	288	8.3	0.000
Diabetes	759	100.0	682	89.9	77	10.1		682	100.0	628	92.1	54	7.9	
Hyperlipidemia	981	100.0	649	66.2	332	33.8		649	100.0	561	86.4	88	13.6	

Factors affecting medication intake and adherence

Table 3 summarizes the multiple logistic regression analysis of medication intake and adherence. Female gender (OR: 1.399, 95% CI: 1.153-1.696), older age, and medical aid coverage (OR: 1.875, 95% CI: 0.948-3.636) were associated with increases in medication intake rates. Compared to 20-39-year-old individuals, 40-59-year-old (OR 3.470, 95% CI 2.399-5.020) and 60+ (OR 4.930, 95% CI 3.334-7.291) had a higher probability of medication intake. Patients with hypertension (OR 6.251, 95% CI 5.173-7.553) and diabetes (OR 5.370, 95% CI 4.047-7.127) had a higher probability of medication intake than those with hyperlipidemia.

The results of medication adherence showed that married (OR 1.394, 95% CI 1.062-1.831), lower educational level and lower household income had a higher probability of medication adherence. Participants with hypertension (OR 1.695, 95% CI 1.301-2.209) and diabetes (OR 1.918, 95% CI 1.328-2.770) had a higher probability of medication adherence than those with hyperlipidemia.

Discussion

This study assessed the differences of medication intake and adherence among people with hypertension, diabetes, and hyperlipidemia in South Korea. A higher probability of medication intake was associated with age increased and medical aid coverage; and higher medication adherence was associated with married, lower education, and lower household income.

In the present study, medication intake and adherence in the older age group was higher than young age groups, while no statistically significant association was found in medication adherence. Several studies have reported the increased medication adherence as age increase (23-25), a possible explanation of this result is that people in older age have more perceived risk of disease (26). Another finding of this study corroborate previous reports that married people were more likely to take medication as prescribed (27, 28). Furthermore, higher medication intake among medical aid beneficiaries can be explained that medical aid beneficiaries in South Korea have almost no restrictions on health care services and medication use. This finding is contrary to a previous study in which medication use may be limited due to financial strain derived from a lack of health insurance coverage (29).

The most important finding of this study is that the type of chronic disease was significantly associated with the medication intake and adherence. People with hypertension and diabetes had a higher probability of both medication intake and adherence than those with hyperlipidemia. The aggressive hyperlipidemia intervention through adequate medication intake and adherence is ur-

gently needed. Korean National Health Insurance Service reported that the prevalence of hyperlipidemia has increased rapidly (from 1.2 million in 2012 to 1.7 million in 2016); the average annual increasing rate was 9.7% for the last 5 years (30). It may be developing at even young ages that affect higher medication non-adherence and the risk of severe complications, such as CVD, stroke, myocardial infarction, even mortality (31, 32).

Table 3: Adjusted odds ratio and their 95% confidence intervals of factors affecting medication intake and adherence from multiple logistic regression

Variable	***Medication intake***			***Medication adherence***		
	OR	95% CI	*P*-value	OR	95% CI	*P*-value
Sex						
Male	1.000			1.000		
Female	1.399	1.153-1.696	0.001	1.109	0.882-1.394	0.376
Age (yr)						
20-39	1.000			1.000		
40-59	3.470	2.399-5.020	0.000	1.049	0.588-1.873	0.870
60+	4.930	3.334-7.291	0.000	1.785	0.981-3.249	0.058
Marital status						
Unmarried/Divorced/Widowed	1.000			1.000		
Married	1.216	0.961-1.541	0.104	1.394	1.062-1.831	0.017
Educational level						
College or above	1.000			1.000		
Elementary school or below	1.206	0.894-1.626	0.220	1.448	1.014-2.067	0.042
Middle-to-High school	1.129	0.917-1.390	0.252	1.339	1.041-1.724	0.023
Medical Coverage						
National Health Insurance	1.000			1.000		
Medical aid	1.857	0.948-3.636	0.041	1.269	0.646-2.490	0.489
Disability						
Non-disabled	1.000			1.000		
Disabled	1.381	0.937-2.034	0.102	1.022	0.688-1.519	0.914
Economic activity						
Participation	1.000			1.000		
Non-participation	1.101	0.899-1.349	0.353	1.091	0.857-1.389	0.480
Residential area						
Rural	1.000			1.000		
Metropolitan	1.054	0.888-1.250	0.550	1.237	1.005-1.523	0.054
Household income						
Q1 (lowest)	1.000			1.000		
Q2	0.812	0.593-1.112	0.195	0.687	0.476-0.991	0.045
Q3	0.828	0.603-1.138	0.245	0.701	0.481-1.022	0.065
Q4	0.898	0.644-1.253	0.527	0.821	0.550-1.227	0.336
Q5 (highest)	0.929	0.661-1.304	0.669	0.861	0.572-1.296	0.473
Type of disease						
Hyperlipidemia	1.000			1.000		
Hypertension	6.251	5.173-7.553	0.000	1.695	1.301-2.209	0.000
Diabetes	5.370	4.047-7.127	0.000	1.918	1.328-2.770	0.001
Model evaluation	Hosmer Lemeshow=11.319 Hosmer Lemeshow P value=0.184			Hosmer Lemeshow=3.222 Hosmer Lemeshow P value=0.920		

Higher medication intake and adherence of hypertension and diabetes than hyperlipidemia can be explained in Korean public health context. Hypertension and diabetes have been national public health priorities in chronic disease management. Patients with these two diseases are more likely to understand their conditions and take medications properly by attending regular health screening, incentive programs, community-based health promotion and/or primary care. However, most middle-aged Koreans are not aware of hyperlipidemia; previous studies have observed poor awareness of hyperlipidemia leading to insufficient management (33-35). Poor awareness of medication may result in inappropriate medication intake and adherence with prescribed treatment (36). In this context, our findings suggest substantial public health intervention is required for hyperlipidemia and its medication.

Medication issues in patients with hyperlipidemia have been challenges to both individuals and public health. Determining the appropriate treatment option for hyperlipidemia is varied according to individual status and needs. Like other chronic disease management, behavioral change or self-manage could be considered in the early stage of hyperlipidemia, then with the possible addition of lipid-lowering medications if needed. Furthermore, patients may not perceive the immediate benefit from medication because of the asymptomatic nature of hyperlipidemia (37). Although medication has been shown to be effective to control the hyperlipidemia, adherence is considered as suboptimal (37, 38). Roughly 33%-50% of patients with hyperlipidemia stopped medication within 1 year after treatment initiation and its adherence decreases over time (39). Poor medication adherence increased the likelihood of hospitalization and lower quality of life for hyperlipidemia patients (40-42).

Hyperlipidemia, as a major risk factor for CVD, significantly increased multimorbidity burden and consequently medical expenditures (21, 43). Under the prevalence rate of hyperlipidemia is increasing, patients require medication therapies not only to properly control the disease but also to prevent disease advancement to multimorbidity. Early screening for abnormal lipid levels at young age might be of clinical value (31). Comprehensive educating for better understanding of hyperlipidemia and its potential health effects is crucial to promoting active engagement in, and adherence to medication.

Patients with chronic diseases have experienced the challenges of medication management during the COVID-19 pandemic. They are unable to access health care services for their routine care and their chronic condition may worsen with the pandemic (44). Patients who manage hyperlipidemia through appropriate medication were not at risk of severe COVID-19 and statin use decreased ICU admission significantly (45). Under the prolonged COVID-19 pandemic, medication intake and adherence for each chronic disease should be implemented at the physician and patient levels. Health care providers or community health centers should provide medication review management by utilizing phone calls, SMS text messaging or tele-monitoring, and constantly interact with their patient to promote medication intake and adherence. In addition, patients are required to engage in medication intake and adherence with an active attitude to stabilize their condition.

We examined the comparison of the type of chronic condition for medication intake and adherence, and the factors affecting medication intake and adherence. The main strength of this study is the use of a continuous and national representative survey. All survey measurements were collected with standardized methods and data accuracy was validated over time. Moreover, these results have important implications for public health approaches in terms of elucidating how chronic disease can be controlled, when it presents solely, not to be advanced, especially for patients with hyperlipidemia.

The present study has important limitations that merit consideration. First, this study was cross-sectional in design. No conclusions on causality can be drawn. Second, medication adherence was measured by self-reported, so it might be subjec-

tive or tend to be overestimated. Third, the severity level of conditions could not be reflected which might significantly influence medication intake and adherence. Last, we were not able to access up-to-date data due to a lack of data availability, and the results of study cannot be generalized to all population.

Conclusion

The rate of medication intake and adherence were significantly lower in patients with hyperlipidemia as compared to those with hypertension and diabetes. Factors influencing on medication intake were female gender, older age, and medical aid. Medication adherence was associated with married, lower educational level and lower household income. Most importantly, since medication intake and adherence of patients with hyperlipidemia were the lowest compared to those with hypertension and diabetes, more intensive medication regimens are needed for patients with hyperlipidemia. It may be helpful to control disease itself and curb the complications and/or multimorbidity expected in the near future. These findings can be used to consider the public health priority for chronic disease management and develop the programs aiming for improved medication adherence.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that there is no conflict of interest.

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