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Effects of Pharmaceutical Cost Containment Policies on Physician Prescribing Behavior

Sylvia Park, Su-Mi Chae, Nam-Soon Kim
Euna Han and Chi-Young Ryu

KIHASA Korea Institute for Health and Social Affairs

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Sylvia Park, Research Fellow

Korea Institute for Health and Social Affairs
Jinhungro 235, Eunpyeong-gu, Seoul 122-705, Korea
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Chapter 1

Introduction

1 Introduction

1. Financial Incentives to Control Pharmaceutical Expenditures

Use of therapeutic agents is one of the core activities in health services. Factors such as population aging, expansion of reimbursements by the National Health Insurance, and new drug developments have been expanding the use of medicinal products, and consequently medication expenses have been increasing rapidly. The burden of increasing medication expenses on the health service budgets is a challenge facing many countries (Hillman et al., 1999; Tele & Groot, 2009; Sood et al., 2009; Wolff, 2011; Godman et al., 2012; Barnieh et al., 2014), and reasonable use of drugs and control over increasing pharmaceutical expenditures have become key policy tasks in the field of health services (Hillman et al., 1999; Tele & Groot, 2009; Sood et al., 2009; Barnieh et al., 2014).

Pharmaceutical expenditures are driven by two major factors: price and volume. Policy tools to control pharmaceutical spending can also be distinguished by approaches to pricing and volume. Direct controls such as price cuts can bring about the effect of reduction in pharmaceutical spending immediately and, for this reason, have been enforced in many countries (Tele & Groot, 2009; Sood et al., 2009; Godman et al., 2013).

When it comes to drug prescriptions, doctors are the most important decision-makers and therefore have been the focus of a considerable number of strategies to induce reasonable pharmaceutical spending (Tele & Groot, 2009; Sood et al., 2009; Godman et al., 2012). On this account, financial incentives have been introduced in many countries as a way of promoting cost-effective prescriptions and containing spending on pharmaceuticals (Ashworth et al., 2000; Sood et al., 2009; Morgan et al., 2012; Brick et al., 2013; Godman et al., 2013). The United Kingdom implemented the General Practitioner Fundholding and Indicative Prescribing schemes to set prescription budget targets and pay incentives if the targets were achieved (Wilson, 1995; Harris, 1996; Rafferty, 1997). In Ireland, an indicative budget scheme was introduced in 1993 to pay an incentive to a general practitioner whose total prescription drug expenditure per patient was lower than the national average (Walley, 2000; Walley & Mossialos, 2004; Brick et al., 2013).

There is little research worldwide into the effects of incentives for prescribing doctors to control spending on medical supplies (Brick et al., 2013), and most of the studies that have been published so far address the effects of financial incentives that were implemented in the UK and Ireland. The studies report that the financial incentives increased doctors' prescriptions of lower-cost drugs (Wilson, 1995; Rafferty, 1997); reduced the number of drug items prescribed (Walley 2000); or produced the effect of reducing spending on prescription drugs (Wilson, 1995; Harris, 1996; Rafferty, 1997; Brick et al., 2013). On the other hand, it is reported that financial incentives for primary care doctors introduced in the UK were not very effective in changing the way they prescribed (Ashworth et al., 2000).

As mentioned above, financial incentives to contain pharmaceutical spending have been implemented mostly under prospective payment systems. Under other payment systems, there have been very few financial incentive schemes that target doctors to control pharmaceutical spending, nor have there been any attempts to assess the effects.

2. Pharmaceutical Expenditures and Use of Therapeutic Agents in Korea

Prescription drug expenses reimbursed by the National Health Insurance System (NHIS) of Korea between 2002 and 2011 continued to grow sharply at an annual average rate of 12.2%, above the growth rate of total medical expenditures (annual average of 10.3%). Pharmaceutical spending accounted for 29% or more of the total NHIS medical expenditures since 2005 (Ministry of Health and Welfare, 2012).

As pharmaceutical costs soared, the government announced a "Drug Expenditure Rationalization Plan", a reform plan to control pharmaceutical spending, in May 2006 and reinforced institutional control over drug prices and reimbursements for drug expenses including the introduction of the Positive List System (PLS) for covered drugs in December 2006. Key policies introduced and implemented in Korea since 2006 include use of economic evaluation in reimbursement decisions, pricing for covered drugs through price negotiations, drug price reassessments, and price-volume agreement systems, which prove that the key objective of the policies has been to control drug prices. In other words, of the two determining factors for pharmaceutical spending, price and volume, government policies have focused on the former. The reason for concentrating on price control rather than volume control in policy efforts to manage pharmaceutical spending is that, compared with volumes—which are associated with complicated and diverse factors—pricing is easier to control with a relatively simple administrative mechanism and tends to produce direct results.

Those policies introduced since 2006 as "Drug Expenditure Rationalization Plan" can be said to be definitely stronger policy efforts compared with those in the past that stood on tenuous scientific grounds for pricing decisions and offered no post-implementation management mechanisms. Nevertheless, it has not been easy to control pharmaceutical spending. Unlike the policy goal—reducing the percentage of pharmaceutical expenditures to the total medical expenditures of the NHIS by 1 pp (percentage point) a year for five years down to 24%—the proportion has not gone any further down than 29% (National Health Insurance Service, 2013, p.88). Also, it turned out that the biggest influence on the size of NHIS pharmaceutical expenditures did not come from drug prices but from growing consumption (Sun-Mee Jang et al., 2010) (see Table 1), spreading awareness of needs for policy intervention into drug consumption, that is, doctors' prescribing practices, to ensure efficiency in pharmaceutical spending.

〈Table 1〉 Factors contributing to increases in NHIS pharmaceutical expenditures

(In %)

Category	2006—2007	2007—2008	2008—2009
Overall pharmaceutical spending growth	12.67	10.37	11.23
Existing Drugs	12.80	9.77	10.11
- Price	-1.90	-3.04	-0.96
- Volume (Consumption)	15.12	13.38	12.00
- Composition Ratio in Generic Name	-0.43	-0.56	-0.93
Newly launched Drugs	1.09	1.44	1.50
Exiting Drugs	-1.21	-0.84	-0.38

Source: Jang et al. (2010). Analysis of Cost Drivers for National Health Insurance Pharmaceutical Expenditures. Health Insurance Review and Assessment Service. p.47.

The National Health Insurance System of Korea reimburses doctors under the "fee for service" system; therefore, doctors have little motivation to cut down on the volume of medical supplies used. The separation of prescribing and dispensing practices in 2000 eliminated motivation for excessive prescription, however, it did not motivate doctors to transform their long-standing prescribing habits. It has been proven in many empirical studies–as seen in the number of drugs per prescription and the habit of prescribing unnecessary medicine for the digestive system (Health Insurance Review and Assessment Service, 2013) as well as preferences for higher-cost drugs (Park et al., 2012)—that doctors in Korea still tend to prescribe medications excessively and that there exists room for reduction.

Antibiotics may cause resistance problems if used improperly. For this reason, many countries have measured consumption of antibiotics with interest (Bergen, 2001; Kuyvenhoven et al., 2003; Adriaenssens et al., 2011; Ashiru-Oredope et al., 2012; Nguyen et al., 2013) and have made institutional efforts to promote reasonable consumption (Mangione-Smith et al., 2005; Goosens et al., 2008; Sabuncu et al., 2009; Zoorob et al., 2012). Also in Korea, antibiotics are one of the strategic targets in efforts to reduce unnecessary prescriptions as they are highly likely to be abused. Antibiotic consumption in Korea remains higher than in other countries:

It was measured at 27.9 DDD/1,000 inhabitants/day in 2010, which was much higher than the OECD average of 19.8 DDD/1,000 inhabitants/day (OECD, 2012). The rate of antibiotics prescribed by clinics for acute upper respiratory tract infections (URIs) in 2012 was 44.26%. It is considerably lower than ten years ago in 2002 when it was 68.29%, but it still needs attention and control (Health Insurance Review and Assessment Service, 2006; Health Insurance Review and Assessment Service, 2013b).

In 2001, the government introduced a "Drug Prescription Monitoring and Feedback" to effectively reduce use of medicines that are likely to be abused, such as antibiotics and injections, and set indicators for targeted prescription patterns. Monitoring and feedback have been carried out on a regular basis, and striking improvements have been achieved in some of the indicators. In the early days of monitoring and feedback, prescribing rates dropped rapidly for the drugs monitored, but the declining trend has since slowed down gradually. This may be explained by responses of medical institutions to prescription monitoring growing weaker or the reality that the smaller the prescription volume becomes, the smaller the room for further reduction grows.

To overcome the limitations of the past policies centered on price control, the government introduced a new financial incentive program called "Outpatient Drug Prescription Incentive

Program" in October 2010, which was designed to contain pharmaceutical spending by inducing doctors to cut down on unnecessary prescriptions by professional judgment without undermining the quality of their medical services. Under the program, which applies to clinics, prescription drug expenses for the half of the current year are estimated for each clinic based on its drug expenditures of the same period of the previous year. If a clinic achieves savings by incurring less actual expenses than its planned estimates and records lower pharmaceutical expenditures than other clinics, it is paid an incentive, within the limit of 20 to 40% of the savings, directly out of the NHIS budget. Measuring the extent of cost savings and paying financial incentives at a clinic level, this program is not only meaningful from a policy perspective in that the goal of the national health insurance policy—efficient pharmaceutical spending—is shared with doctors who treat patients under the fee-for-service system; but it is also noteworthy in that it is a cost-saving policy enforced with a new method that is attempted for the first time in Korea. After evaluations were completed for the first half of 2011, the first half-year since the implementation of the program, 7,345 of the total clinics evaluated (21,325) received an incentive (press release by the Ministry of Health and Welfare on November 24, 2011).

In the meantime, the government carried out an across-the-board mark-down of drug prices in April 2012 to alleviate pharmaceutical spending increases. Of an estimated total of 14,000 listed drugs, 7,500 were targeted for the price cut initiative, and their prices were lowered by an average of 14%. Also, prices of originator brands were adjusted collectively to 53.55% of their existing prices by eliminating price differences between originator brands whose patents had expired for more than a year and generic counterparts. Such price cuts and pricing structure changes across the entire pharmaceutical market may have impact not only on the size of pharmaceutical spending but also on prescribing behaviors, especially those associated with pricing and expenses.

Financial incentive program for clinics and across-the-board price cuts represent the latest pharmaceutical spending control policies targeting the volumes and prices of drugs consumed, respectively. The two policies share the same ultimate goal of containing pharmaceutical spending, but they are typical policies with two different approaches and expected to affect drug prescription practices in different ways.

3. Research Purpose

The purpose of this study is to analyze the impact of the financial incentive program and the across-the-board price cut —both designed to save on prescription drug expenses—on prescription drug expenditures. We analyzed how the incentive system affected doctors' prescription of antibiotics for infectious diseases. This is the first empirical study in Korea that analyzes the effects of the strategy of providing prescribing doctors with financial incentives to contain prescription drug expenditures under the fee-for-service system. It is expected to serve as a reference for many countries that seek policy to achieve pharmaceutical cost savings.

Chapter 2
Methods

2 Methods

1. Data

We used NHIS claims data for analysis. More than 95% of the Korean population are National Health Insurance subscribers, and all the medical institutions in Korea, including clinics, have contracts with the NHIS and have the obligation of providing medical services to NHIS enrollees. Clinics file claims for medical expenses with the NHIS on a daily basis after treating outpatients, and the claims data include treatment details as well as prescription details for each patient on each visit.

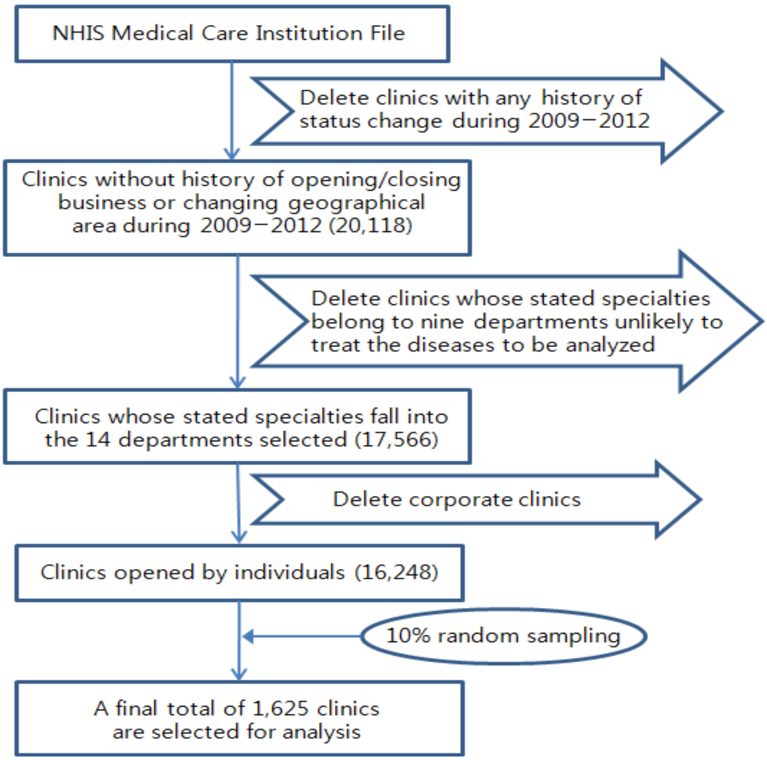
For analysis, we used outpatient treatment and drug prescription data for four years from January 1, 2009 until December 31, 2012 out of the data of claims filed by clinics with the NHIS. More specifically, we used the following data held by the Health Insurance Review and Assessment Service (HIRA): General Statement (200), Medical Treatment Statement (300), Examinee Disease Statement (400) and Out-of-Clinic Prescription Statement (530). The General Statement is prepared for each medical expense claim filed by a medical institution, and clinics are required to prepare claim statements on a daily basis. Therefore, clinic claims data, which are the subject of this study, can be said to be individual patients' daily visit data. The General Statement (200) provides basic data such as medical care institution code, the patient's sex and age, principal KCD[1] code, secondary KCD code, out-of-clinic prescription drug costs, and total medical expenses. The Medical Treatment Statement (300) contains information on prescription drugs to be dispensed in the clinic including details of pharmaceutical code, dosage, length of administration and pharmaceutical costs. The Out-of-Clinic Prescription Statement (530) has information on prescription drugs to be dispensed out of the clinic including details of pharmaceutical code, dosage, length of administration and pharmaceutical costs. The Examinee Disease Statement (400) shows information on the name of the patient's disease or injury including the principal and secondary KCD codes. Each of the statements can be linked together using the Join key.

Since the purpose of this study is to analyze changes in the prescribing patterns of doctors relative to policy changes, we included only the clinics that had treated patients continuously for the duration of the target period. To this end, we first selected, from the NHIS medical care institution file, clinics that were deemed to have continued to treat patients in a certain area between 2009 and 2012 without any history of opening or closing business or changing its geographical area during the

1) KCD stands for Korean Classification of Diseases.

period. Clinics that met this criterion totaled 20,118. Next, we extracted clinics specializing in 14 departments (family medicine, internal medicine, anesthesiology, urology, obstetrics and gynecology, pediatrics, neurology, neurosurgery, surgery, otolaryngology, orthopedics, dermatology, cardiac surgery and general practice), which numbered 17,566 in total. After that, institutions established by a corporation were excluded, and a total of 16,248 institutions set up by individuals were selected. The reason for excluding corporate institutions is that the purpose of this study focused on prescription decisions by individual doctors in relation to policy changes and that therefore any potential influence of corporate goals on doctors' decisions needed to be eliminated. To select samples equivalent to 10% of the extracted medical care institutions, we went through the random sampling process and selected a final total of 1,625 institutions for analysis (see Figure 1).

[Figure 1] Process of sampling medical institutions for analysis



2. Analysis Model and Parameter Measurements

Target diseases to be analyzed were selected from those frequently found in primary care settings: Gastric ulcers (K25) and gastroesophageal reflux diseases (K21), acute upper respiratory infections (J00-J06), acute lower respiratory infections (J20-J22), otitis media (H65, H66), and infections in the urinary system including cystitis (N30) and other disorders of the urinary system (N39). Acute upper respiratory tract infections (URI), acute lower respiratory tract infections (LRI) and otitis media (otitis media) were divided into infections among adults (20 years and above) and those among children (19 years and below), while only adults aged 20 years and above were included for gastric ulcers, gastroesophageal reflux diseases (GERD), and infections in the urinary system. Among the claims data of the extracted clinics, all the claims whose principal diagnosis was one of the above were included in our analysis, which was carried out on a disease by disease basis.

The analysis for this study is divided into two parts. The first analysis deals with expenses. Two indicators were calculated for each disease: pharmaceutical and medical expenditures per claim. Pharmaceutical expenditure per claim refers to the sum of all the expenditures on therapeutic agents prescribed for a patient. The reason for analyzing it is that the financial incentive program assesses prescription drug costs and that therefore it is warranted to look into changes in pharmaceutical spending before anything else.

Medical expenditure per claim refers to the sum of all the expenses incurred for treating a patient except for prescription drug costs. The financial incentive system for clinics is intended to reduce spending on prescription drugs. However, even if financial incentives lead to reduction in drug expenses, they are not a desirable system if the rest of the expenses go up and the total expenses do not decrease after all. It is warranted, therefore, to look into changes not only in total pharmaceutical expenditures but also in the rest of the medical expenditures.

In our second analysis, we measured five indicators related to the patterns of prescribing antibiotics, principal therapeutic agents for the target infectious diseases, excluding gastric ulcers (K25) and GERDs (K21). In general, antibiotics are not recommended for acute URIs. Nevertheless, they are often prescribed, and there has been suspicion of inappropriate use of antibiotics (Mangione-Smith et al., 2005; NPS, 2006; Zoorob et al., 2012). The UK National Institute for Health and Care Excellence (NICE) does not recommend use of antibiotics for respiratory diseases including URIs, LRIs and some of the otitis media (acute otitis media) in primary care settings (2008). In Australia, the National Prescribing Service does not recommend use of antibiotics for an acute otitis media unless accompanied by a severe fever or vomiting, saying that it is a self-limiting disease, and monitors the quality of prescriptions.

The first analysis indicator for antibiotic prescribing practices in infectious diseases is the prescribing rate, a percentage of antibiotics prescribed for a disease in claims. To contain drug expenses, a doctor can leave out an antibiotic in their prescription for an infectious disease for which it is not essential.

The second indicator is the number of antibiotics prescribed.

It measures how many antibiotics with different product names were prescribed for a disease in reimbursement claims. Another way of reducing prescription drug expenses that doctors can choose is to change their behavior from prescribing two or more antibiotics at the same time to prescribing one. This is why the number of antibiotics prescribed was analyzed.

The third indicator for prescribing behavior is the length of administration. In claims with an antibiotic prescribed, the length of administration means days for which the antibiotic is prescribed to be taken. If a claim had two or more antibiotics prescribed for different numbers of days, the longest number of days was selected as the length of administration for the claim. The length of administration is one of the factors that affect pharmaceutical spending, and considering the fact that the samples of this study are mostly acute diseases, it is believed that doctors can help contain pharmaceutical spending by prescribing less days of taking an antibiotic if there is room for reduction without affecting treatment results.

The fourth prescribing indicator is the rate of injection. It measures what percentage of antibiotic prescriptions were for injection. It is calculated by putting the number of antibiotics prescribed in the denominator and the number of antibiotic injections in the numerator. The purpose of analyzing antibiotic injections is to analyze changes in the tendency of prescribing an injection, a higher-cost treatment, instead of an oral antibiotic in cases where both oral and injectable antibiotics (with the same ingredients) are covered by insurance and therefore an oral antibiotic can be used instead of an injection. Therefore, injectable antibiotics included in the analysis are limited to those whose oral counterparts with the same ingredients are on the NHIS list.

The fifth indicator measures the percentage of high-priced drug prescriptions, which apply to claims in which the highest-cost antibiotic was prescribed even though other less expensive antibiotics with the same ingredients, formulations and content were available on the coverage list. To define high-priced drugs, we adopted the definition used by the HIRA to monitor high-priced drug prescriptions. The HIRA maintains a list of high-priced medications by identifying those for which three or more items with the same ingredients, formulations and content are on the coverage list but priced differently and by selecting the highest-cost of the listed items. The percentage of high-priced drugs is determined by putting the number of antibiotics prescribed in each claim in the denominator and the number of high-priced antibiotics in the numerator. Doctors can choose lower-priced items over higher-priced ones as long as they have the same ingredients, formulations and content if they would help reduce pharmaceutical spending in response to policy changes. Therefore, we can expect a decrease in the tendency of using high-cost medications.

3. Statistical Analysis

To analyze the impact of drug policy changes on doctors' patterns of prescribing drugs, we performed an interrupted time series analysis on a monthly basis from January 2009 to December 2012. To do this, we converted the pharmaceutical and medical expenditures measured at the claim level as well as the parameters of antibiotic prescription indicators for infectious diseases into clinic-level averages and then converted the results into monthly averages again. October 2010, when the financial incentive program went into force, was used as a timing basis for policy change, and April 2012, when drug prices were marked down across the board was also used as another. The timing of the price cut was included only in the analysis of per-claim pharmaceutical expenditures, per-claim medical expenditures and high-priced drug prescription rates. The policy change timing of the price cut was not applied to the time series analysis for the rest of the five antibiotic prescription indicators, other than high-priced drug prescription rates, because it was assumed that cutting drug prices across the board would not have affected antibiotic prescription rates, the number of prescribed drugs, the length of administration, or the tendency of prescribing injections.

The interrupted time series analysis model for per-claim pharmaceutical expenditure, per-claim medical expenditure and high-priced drug prescription rate is as follows (Formula 1):

$$Y_t = \beta_0 + \beta_1 \times \text{TIME1}_t + \beta_2 \times \text{POLICY1}_t + \beta_3 \times \text{TIME2}_t + \beta_4 \times \text{POLICY2}_t + \beta_5 \times \text{TIME3}_t + e_t \quad \text{Formula (1)}$$

where Y is an analysis indicator value, such as monthly per-claim pharmaceutical expenditure, per-claim medical expenditure or high-priced drug prescription rate, and t refers to time, which changes on a monthly basis between January 2009 and December 2012. TIME1 is a continuous variable that starts with the value of "1" for January 2009 and increases by one as the months change. It represents a monthly time-series trend. POLICY1 is a dummy variable representing the implementation of the financial incentive program in October 2010. TIME2 shows a change of time-series trend after POLICY1 implementation. This variable starts with 1 for October 2010 and increases by one for each month. POLICY2 is also a dummy variable for the implementation of the across-the-board price cut in April 2012, while TIME3 is a continuous variable that increments by one, starting in April 2012. TIME3 represents a change of time-series trend after POLICY2.

The interrupted time series analysis model for antibiotic prescribing rate, the number of antibiotics prescribed, the length of administration and antibiotic injection prescribing rate is as follows (Formula 2):

$$Y_t = \beta_0 + \beta_1 \times \text{TIME1}_t + \beta_2 \times \text{POLICY1}_t + \beta_3 \times \text{TIME2}_t + e_t \qquad \text{Formula (2)}$$

where *Y, t,* TIME1, POLICY1 and TIME2 have the same meanings as in Formula (1).

When it comes to time-series data, such as the monthly data used in this study, errors in observed values are co-related to those at the immediately preceding point of time. Unless they are corrected, policy effects will be exaggerated. To resolve this problem, we carried out an interrupted time series analysis using the AUTOREG procedure of SAS. For drug prescribing indicator values, we included not only the values of the immediately preceding lags but also higher lags of the time series in autocorrelation tests because seasonality may also exert impact. The presence of autocorrelation was detected using the Durbin-Watson Statistic (Wagner et al., 2002).

Chapter 3
Results

3 Results

1. General Overview

A. General overview of medical institutions to be analyzed

The general characteristics of 1,625 clinics selected through sampling are presented in Tables 2 and 3. Among the 1,625 doctors who owned the sampled clinics, males account for 87.3%, while 12.7% are female. In terms of age, those in their 40s and 50s account for the majority at 43.0% and 37.5%, respectively (see Table 2).

〈Table 2〉 Distribution of characteristics of doctors who owned the sampled clinics

Characteristics of Doctors Who Owned the Clinics		Number of Clinics	
		Count	Percentage (%)
Sex	Male	1,419	87.3
	Female	206	12.7
Age Group	30s	31	1.9
	40s	698	43.0
	50s	609	37.5
	60s	200	12.3
	70s	66	4.1
	80s	21	1.3
Total		1,625	100

The stated specialty of a clinic represents the department of medicine in which the doctor specializes. General practice (25.7%) accounts for the highest percentage, followed by internal medicine (19.0%), otolaryngology (9.1%), pediatrics (8.6%) and orthopedics (8.4%) (See Table 3).

〈Table 3〉 Stated specialties of the sampled clinics

Stated Specialty	Number of Clinics	
	Count	Percentage (%)
General Practice	418	25.7
Internal Medicine	309	19.0
Otolaryngology (ENT)	147	9.1
Pediatrics	139	8.6
Orthopedics	137	8.4
Obstetrics and Gynaecology	97	6.0
Urology	77	4.7
Dermatology	77	4.7
Surgery	69	4.3
Family Medicine	57	3.5
Anesthesiology	52	3.2
Neurosurgery	31	1.9
Neurology	9	0.6
Cardiac Surgery	6	0.4
Total	1,625	100

B. General overview of disease-specific analysis data

Table 4 shows the demographic distribution of patients in claims used to calculate pharmaceutical and medical expenditures for each disease and visit. Based on the claims between 2009 and 2012 used in this study, upper respiratory tract infections (adults) account for the majority at 10,196,874, and male and female patients are 37.0% and 63.0%, respectively. In terms of age, those between 20 and 64 years old account for 82.9%, while those 65 years and above take up 17.1%. There are a total of 8,858,594 claims for acute URIs (children), while there are 6,215,723 for acute LRIs (children) and 1,926,152 for otitis media (children). Infections in the urinary system (adults) account for the lowest percentage at 885,453. In this category, females account for 94.2%, absolutely higher than males. Since the statistical analysis of this study was performed with monthly data, it is necessary to look into the demographic distribution of the claims for each disease also on a monthly basis. As a result of the analysis, the demographic distributions of the claims for each disease for the 48 months shows similar tendencies, without big fluctuations.

〈Table 4〉 Demographic characteristics of claims analyzed for pharmaceutical and medical expenditures

Disease	Category		Claims (Count)	Percentage (%)
Gastric ulcers and gastroesophageal reflux diseases－adults	Total		1,907,035	100
	Sex	Male	782,358	41.0
		Female	1,124,677	59.0
	Age	20-64 years	1,360,659	71.3
		65 years and above	546,376	28.7
Acute upper respiratory infections－children	Total		8,858,594	100
	Sex	Male	4,584,375	51.8
		Female	4,274,219	48.2
	Age	1 year and below	1,162,017	13.4
		2-11	5,851,222	66.5
		12-19	1,845,355	20.1

Disease	Category		Claims (Count)	Percentage (%)
Acute upper respiratory infections－adults	Total		10,196,874	100
	Sex	Male	3,776,579	37.0
		Female	6,420,295	63.0
	Age	20-64 years	8,467,967	82.9
		65 years and above	1,728,907	17.1
Acute lower respiratory infections－children	Total		6,215,723	100
	Sex	Male	3,252,160	52.4
		Female	2,963,563	47.6
	Age	1 year and below	868,081	14.2
		2-11 years	4,423,848	71.7
		12-19 years	923,794	14.2
Acute lower respiratory infections－adults	Total		5,706,604	100
	Sex	Male	2,143,151	37.4
		Female	3,563,453	62.6
	Age	20-64 years	4,460,098	78.0
		65 years and above	1,246,506	22.0
Otitis media－children	Total		1,926,152	100
	Sex	Male	1,035,972	53.8
		Female	890,180	46.2
	Age	1 year and below	413,467	21.5
		2-11 years	1,375,698	71.2
		12-19 years	136,987	7.3
Otitis media－adults	Total		903,344	100
	Sex	Male	375,298	41.6
		Female	528,046	58.4
	Age	20-64 years	652,787	72.2
		65 years and above	250,557	27.8
Cystitis and other disorders of the urinary system－adults	Total		885,453	100
	Sex	Male	51,230	5.8
		Female	834,223	94.2
	Age	20-64 years	688,222	77.7
		65 years and above	197,231	22.3

Table 5 shows the number of month-clinics found in clinic-specific data and monthly data as well as the number of monthly claims found in clinic-specific data for the 2009-2012 period used in the analyses. When constructing clinic-level data and monthly data, we included only the clinics that filed at least 30 claims a month for a disease. The number of month-clinics in the four-year data was the highest for URIs (adults) at 38,020, where monthly claims per clinic was 255 on average. The disease with the smallest number of month-clinics in the analysis was otitis media (adults) at 6,179, and its average number of monthly claims per clinic was 104.

〈Table 5〉 Number of month-clinics and monthly per-clinic claims analyzed for principal agents

Disease	Number of month-clinics	Number of Claims per Clinic per Month	
		Average	Standard Deviation
Gastric ulcers and gastroesophageal reflux diseases－adults	13,851	121.4	145.4
Acute upper respiratory infections－children	28,105	296.2	379.1
Acute upper respiratory infections－adults	38,020	255.4	288.8
Acute lower respiratory infections－children	21,581	275.7	405.2
Acute lower respiratory infections－adults	28,623	191.3	187.1
Otitis media－children	10,978	154.8	190.6
Otitis media－adults	6,179	104.0	109.6
Cystitis and other disorders of the urinary system－adults	7,070	65.8	40.8

2. Effects of Pharmaceutical Policy Changes on Drug Prescriptions

A. Pharmaceutical expenditures per claim

To analyze the first indicator—aspects of changes in per-claim prescription drug expenditures—over the period of January 2009 through December 2012, we first divided the period into three parts on the basis of when a policy was introduced and then calculated average pharmaceutical expenditures. The first part covers the time span between January 2009 and September 2010, which is before the implementation of the financial incentive program. The second is October 2010–March 2012, which is after the implementation of the incentive program and before the across-the-board price cut. The third is the period after April 2012 when the price cut was executed and the incentive program remained in force.

Table 6 presents results of calculating pharmaceutical expenditures per claim for each disease over the three time spans. Pharmaceutical expenditures per claim for gastric ulcers and GERDs (adults) declined gradually: It was 21,980 won on average before the implementation of financial incentives; 21,533 won on average between after the implementation and before the price cut; and 17,227 won after the price cut. The average spending per claim also continued to decrease for URIs (children). For the rest of the diseases, it was higher in the second time span than in the first. That is, the average spending per claim was higher after the introduction of financial incentives than before. After drug prices were cut down across the board, however, it declined again.

〈Table 6〉 Prescription drug expenditures per claim before and after policy change

(In Korean won)

Disease	Pharmaceutical Expenditures by Policy Time Span					
	January 2009−September 2010		October 2010−March 2012		April 2012−December 2012	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
Gastric ulcers and gastroesophageal reflux diseases−adults	21,980.3	343.6	21,533.0	675.7	17,227.1	317.6
Acute upper respiratory infections−children	4,011.4	148.0	3,988.3	139.6	3,324.2	116.3
Acute upper respiratory infections−adults	5,373.9	161.0	5,413.6	119.2	4,700.1	53.0
Acute lower respiratory infections−children	4,987.4	178.6	5,150.6	122.5	4,391.8	143.3
Acute lower respiratory infections−adults	6,803.1	211.9	6,999.8	125.8	6,358.2	155.7
Otitis media−children	5,505.8	221.5	5,701.4	188.4	4,497.1	235.0
Otitis media−adults	5,119.8	317.4	5,504.9	201.6	4,711.2	179.7
Cystitis and other disorders of the urinary system−adults	8,620.7	335.4	9,080.7	199.3	7,516.7	173.4

Table 7 shows results of an interrupted time series analysis on the impact of policy changes on pharmaceutical spending per claim. During the period of time before the incentive scheme was implemented, pharmaceutical spending per claim for all the diseases analyzed showed an upward trend (TIME1) that was statistically significant.

Such a trend changed after financial incentives were introduced. The introduction of the new policy (POLICY1) brought about immediate change in per-claim drug expenses for gastric ulcers and GERDs (adults), acute LRIs (adults) and otitis media (children and adults): The spending for otitis media (adults) decreased, while it increased for the other three diseases. Immediately after the incentive scheme was enforced, drug expenditures per claim went up by 367 won for gastric ulcers and GERDs (adults), by 99 won for acute LRIs (adults) and by 151 won for otitis media (children). By contrast, the spending for otitis media (adults) went down by 171 won immediately.

The introduction of the financial incentive program significantly reduced over-time pharmaceutical spending per claim (TIME2) for all the target diseases. For gastric ulcers and GERDs (adults), acute URIs (children and adults), acute LRIs (children, adults) and otitis media (children) in particular, the net effect after adding up the TIME1 and TIME2 effects turned out to be negative, which means that per-claim pharmaceutical spending reversed its course to decline gradually over time.

The second policy change, the across-the-board price cut (POLICY2), immediately pulled down pharmaceutical expenditures per claim for all the target diseases by a statistically significant extent. Pharmaceutical spending per claim for gastric ulcers and GERDs (adults) right after the price cut dropped by 3,477 won, while the spending for otitis media (children) went down by 1,264 won and by 1,828 won for infections in the urinary system (adults).

However, monthly trends of pharmaceutical spending per claim (TIME3) started to rise again after the price cut. Such turnarounds are statistically significant for gastric ulcers and GERDs (adults), acute URIs (children, adults), acute LRIs (children, adults) and otitis media (children). Consequently, it turns out that pharmaceutical expenditures per claim recorded a net growth every month for all the diseases (TIME1 + TIME2 + TIME3).

〈Table 7〉 Results of interrupted time series analysis on prescription drug expenses per claim

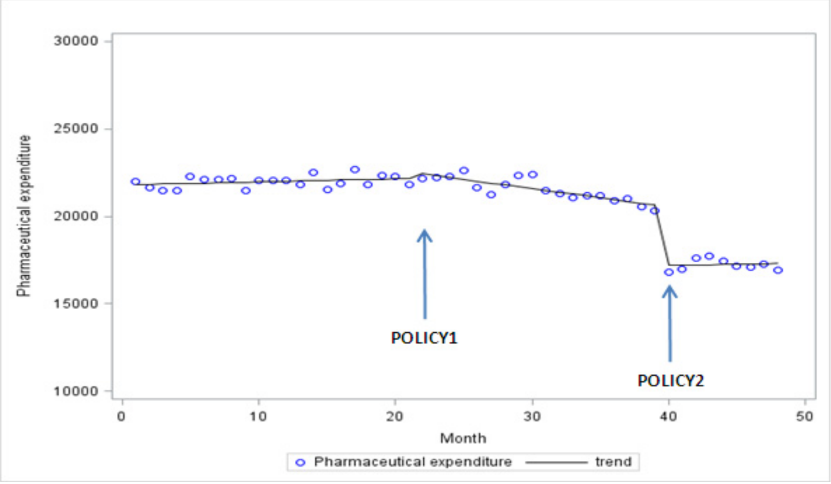
Disease (Total R^2)	Parameter	β Estimate (SE)	p
Gastric ulcers and gastroesophageal reflux diseases－adults (0.9760)	Intercept	21798 (92.6845)	<.0001
	TIME1*	17.4281 (7.4911)	0.0251
	POLICY1*	367.2021 (142.4934)	0.0138
	TIME2**	-122.1096 (11.4733)	<.0001
	POLICY2**	-3477 (240.0961)	<.0001
	TIME3**	119.6076 (36.6627)	0.0023

Disease (Total R^2)	Parameter	β Estimate (SE)	p
Acute upper respiratory infections－children (0.9109)	Intercept	3914 (47.1043)	<.0001
	TIME1**	8.3457 (2.774)	0.0045
	POLICY1	86.2548 (43.9727)	0.0566
	TIME2**	-28.1795 (4.2773)	<.0001
	POLICY2**	-572.475 (79.5994)	<.0001
	TIME3**	36.9881 (12.4331)	0.0049
Acute upper respiratory infections－adults (0.9136)	Intercept	5243 (77.9759)	<.0001
	TIME1*	10.7826 (4.1137)	0.0123
	POLICY1	126.1573 (62.6661)	0.0509
	TIME2**	-28.379 (6.273)	<.0001
	POLICY2**	-718.897 (100.5828)	<.0001
	TIME3**	44.8967 (16.503)	0.0096
Acute lower respiratory infections－children (0.8938)	Intercept	4752 (50.0755)	<.0001
	TIME1**	21.1314 (3.2901)	<.0001
	POLICY1	62.6937 (53.7279)	0.25
	TIME2**	-33.1564 (5.1478)	<.0001
	POLICY2**	-759.447 (91.6974)	<.0001
	TIME3*	36.2243 (14.2455)	0.0149
Acute lower respiratory infections－adults (0.9029)	Intercept	6499 (45.6325)	<.0001
	TIME1**	26.1912 (2.7841)	<.0001
	POLICY1*	99.1947 (44.5965)	0.0317
	TIME2**	-40.6323 (4.3189)	<.0001
	POLICY2**	-739.383 (79.309)	<.0001
	TIME3**	55.3806 (12.366)	<.0001
Otitis media－children (0.9212)	Intercept	5373 (72.2855)	<.0001
	TIME1**	12.636 (4.2383)	0.0048
	POLICY1*	150.8559 (67.4374)	0.0308
	TIME2**	-24.1702 (6.531)	0.0006
	POLICY2**	-1264 (122.9479)	<.0001
	TIME3**	51.8637 (19.1489)	0.0098

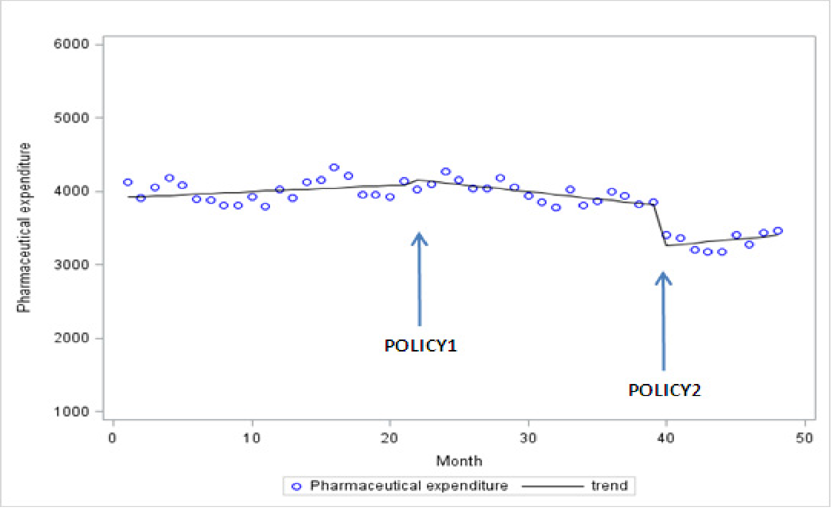
Disease (Total R^2)	Parameter	β Estimate (SE)	p
Otitis media－Adults (0.8566)	Intercept	4660 (93.8423)	<.0001
	TIME1**	42.488 (4.3527)	<.0001
	POLICY1*	-170.952 (68.1036)	0.0162
	TIME2**	-31.6727 (6.5263)	<.0001
	POLICY2**	-967.857 (130.8904)	<.0001
	TIME3	17.1062 (20.5937)	0.4111
Cystitis and Other Disorders of the Urinary System－Adults (0.8949)	Intercept	8193 (95.734)	<.0001
	TIME1**	38.8424 (7.6242)	<.0001
	POLICY1	-12.4633 (136.998)	0.9279
	TIME2*	-29.9932 (12.2683)	0.0188
	POLICY2**	-1828 (181.0642)	<.0001
	TIME3	28.9052 (28.9546)	0.3239

* $p<0.05$, ** $p<0.01$

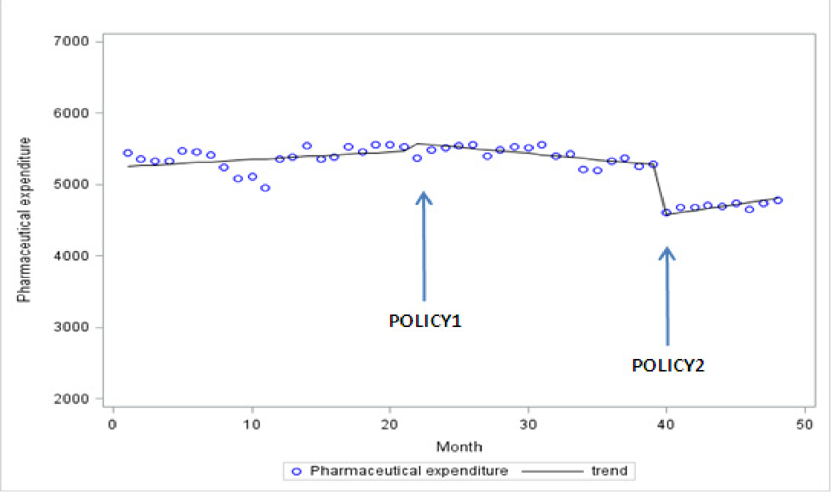
[Figure 2] Changes in pharmaceutical expenditures per claim for gastric ulcers and GERDs (adults)



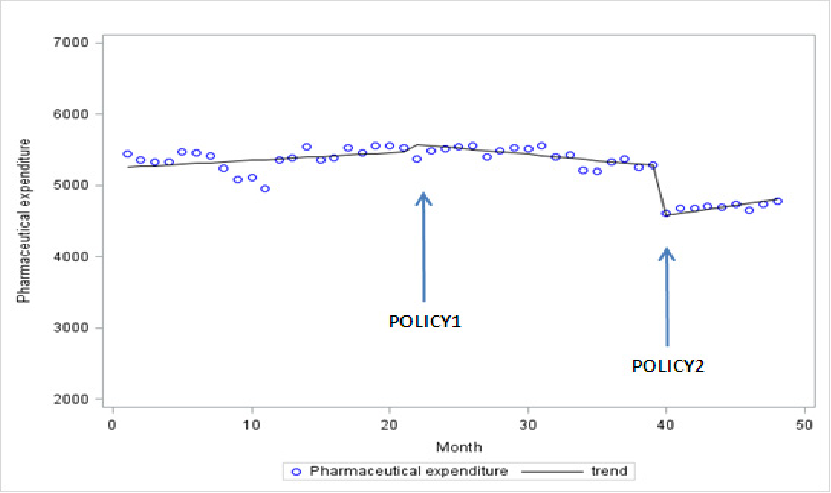
[Figure 3] Changes in pharmaceutical expenditures per claim for acute URI (children)



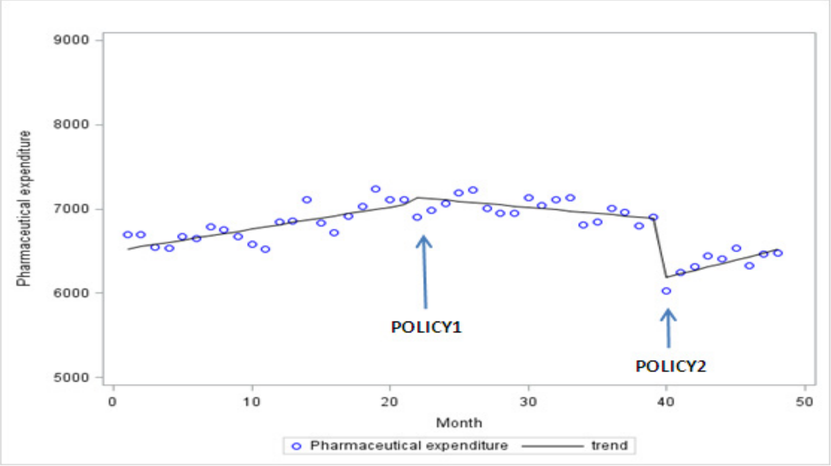
[Figure 4] Changes in pharmaceutical expenditures per claim for acute URI (adults)



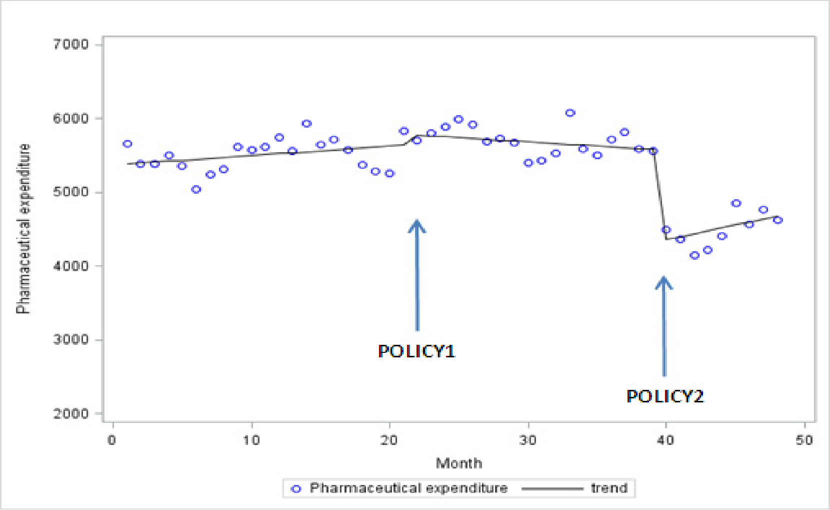
[Figure 5] Changes in pharmaceutical expenditures per claim for acute LRI (children)



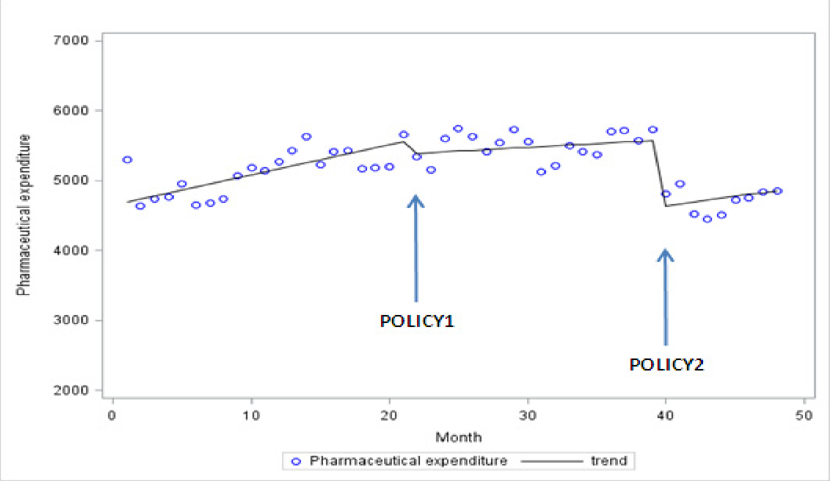
[Figure 6] Changes in pharmaceutical expenditures per claim for acute LRI (adults)



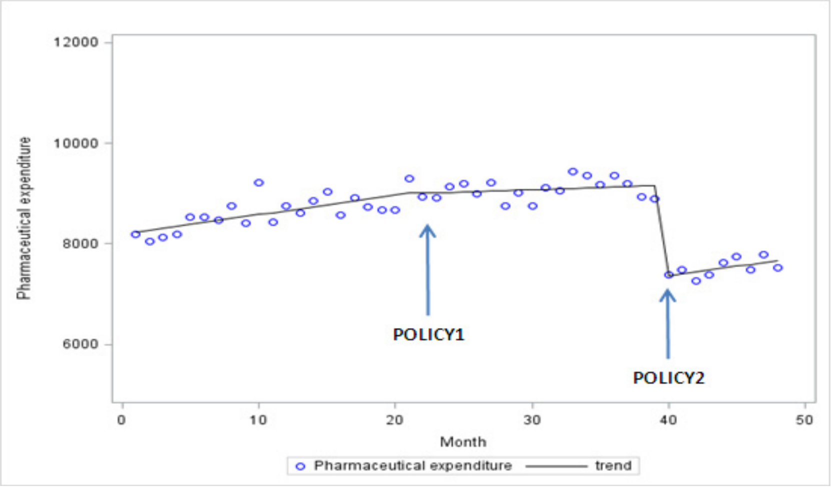
[Figure 7] Changes in pharmaceutical expenditures per claim for otitis media (children)



[Figure 8] Changes in pharmaceutical expenditures per claim for otitis media (adults)



[Figure 9] Changes in pharmaceutical expenditures per claim for cystitis and other disorders of the urinary system (adults)



B. Medical expenditures per claim

Table 8 shows results of analyzing medical expenditures per claim for the target diseases for each time span associated with policy change. Medical expenditures per claim decreased gradually for gastric ulcers and GERDs (adults), while they continued to rise for the rest.

〈Table 8〉 Medical expenditures per claim before and after policy change

(In Korean won)

Disease	Medical Expenditures by Policy Time Span					
	January 2009–September 2010		October 2010–March 2012		April 2012–December 2012	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
Gastric ulcers and gastroesophageal reflux diseases–adults	18,728.4	753.2	17,818.2	712.1	17,536.2	516.3
Acute upper respiratory infections–children	11,355.1	217.4	11,705.3	224.0	12,044.1	136.0
Acute upper respiratory infections–adults	11,932.4	204.7	12,330.4	196.9	12,657.9	93.4
Acute lower respiratory infections–children	11,098.4	213.8	11,418.3	195.2	11,731.1	101.9
Acute lower respiratory infections–adults	11,784.6	209.5	12,171.2	191.7	12,480.0	125.4
Otitis media–children	11,075.5	241.5	11,323.9	156.4	11,569.5	105.0
Otitis media–adults	13,279.4	313.4	13,681.2	321.2	14,073.3	245.6
Cystitis and other disorders of the urinary system–adults	14,580.2	487.2	15,118.3	824.3	16,134.7	614.6

A time series analysis of changes in per-claim medical expenses following policy changes shows that the introduction of the outpatient prescription incentive program and across-the-board price cut had little impact on the expenses. As shown in Table 9, medical expenditures per claim for all the diseases, except for gastric ulcers and GERDs (adults) as well as infections in the urinary system (adults), had been on a steady increase over time by a statistically significant extent even before the policy change (TIME1). A statistically significant impact of the introduction of financial incentives was observed only in otitis media (children): The per-claim medical expenditure went down by 146 won immediately after the implementation of the program. Such results indicate that the reduction in pharmaceutical spending was not offset by the increase in medical expenditures.

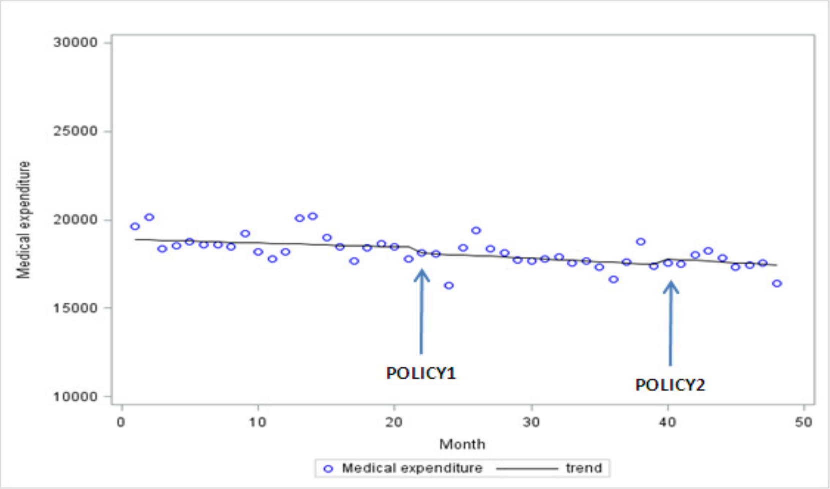
〈Table 9〉 Results of interrupted time series analysis on medical expenditures per claim

Disease (Total R^2)	Parameter	β Estimate (SE)	p
Gastric ulcers and gastroesophageal reflux diseases－adults (0.7095)	Intercept	18905 (292.5898)	<.0001
	TIME1	-21.5651 (13.8128)	0.1263
	POLICY1	-297.108 (218.0006)	0.1805
	TIME2	-15.5899 (20.7788)	0.4575
	POLICY2	343.1693 (417.6803)	0.4162
	TIME3	-4.3969 (65.5079)	0.9468
Acute upper respiratory infections－children (0.9083)	Intercept	11044 (56.1197)	<.0001
	TIME1**	26.4768 (4.6045)	<.0001
	POLICY1	-160.4861 (88.5518)	0.0776
	TIME2	3.7074 (6.7932)	0.5883
	POLICY2	-13.0473 (130.8113)	0.9211
	TIME3	-20.1769 (23.0924)	0.3876
Acute upper respiratory infections－adults (0.9519)	Intercept	11623 (29.0200)	<.0001
	TIME1**	24.9729 (2.3737)	<.0001
	POLICY1	-17.576 (45.5122)	0.7015
	TIME2	-1.1462 (3.2673)	0.7276
	POLICY2	7.8237 (88.2771)	0.9298
	TIME3	-6.7054 (15.6562)	0.6708

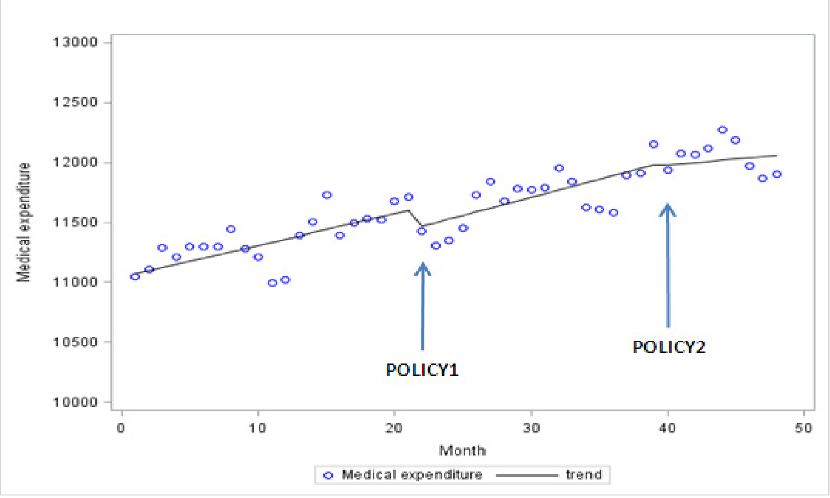
Disease (Total R^2)	Parameter	β Estimate (SE)	p
Acute lower respiratory infections－children (0.9277)	Intercept	10801 (75.5095)	<.0001
	TIME1**	24.218 (2.8276)	<.0001
	POLICY1	-52.496 (42.6783)	0.2259
	TIME2	-4.7257 (4.1901)	0.2661
	POLICY2	43.5083 (83.6768)	0.606
	TIME3	0.6366 (13.1175)	0.9615
Acute lower respiratory infections－adults (0.9436)	Intercept	11482 (28.9735)	<.0001
	TIME1**	23.9343 (2.3652)	<.0001
	POLICY1	39.9037 (45.3415)	0.3842
	TIME2	-6.0774 (3.2665)	0.0704
	POLICY2	97.6924 (89.9309)	0.284
	TIME3	-8.2748 (15.8718)	0.6051
Otitis media－children (0.8892)	Intercept	10692 (28.4816)	<.0001
	TIME1**	32.3975 (2.3304)	<.0001
	POLICY1**	-146.3038 (45.2443)	0.0025
	TIME2**	-21.4855 (3.2799)	<.0001
	POLICY2	179.1527 (90.0561)	0.0535
	TIME3	-11.2091 (14.9879)	0.4589
Otitis media－adults (0.8281)	Intercept	12886 (107.731)	<.0001
	TIME1**	36.2782 (8.6896)	0.0002
	POLICY1	-292.9566 (158.3892)	0.0718
	TIME2	-2.6301 (13.2122)	0.8432
	POLICY2	29.4846 (234.6223)	0.9006
	TIME3	-10.6308 (45.8266)	0.8177
Cystitis and other disorders of the urinary system－adults (0.5932)	Intercept	14720 (389.6985)	<.0001
	TIME1	-10.2881 (30.4979)	0.7376
	POLICY1	-140.1346 (515.4221)	0.7871
	TIME2	85.8449 (50.6014)	0.0974
	POLICY2	-67.5717 (632.3602)	0.9154
	TIME3	28.8391 (109.7919)	0.7941

* $p<0.05$, ** $p<0.01$

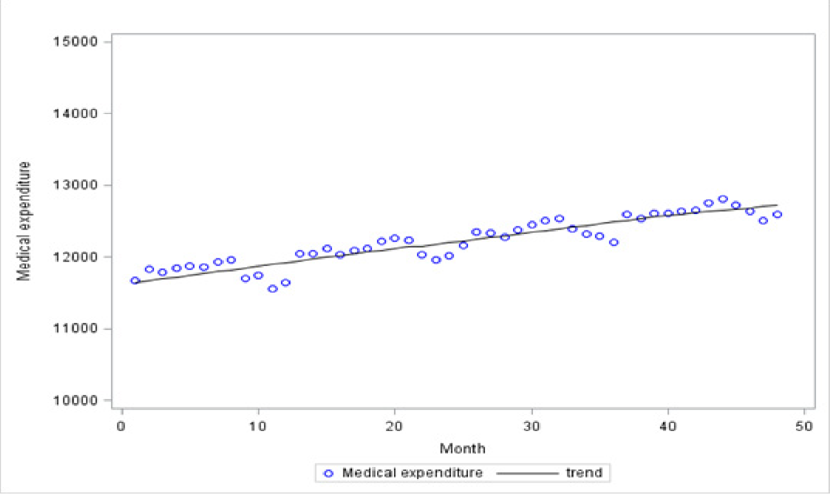
[Figure 10] Changes in medical expenditures per claim for gastric ulcers and GERDs (adults)



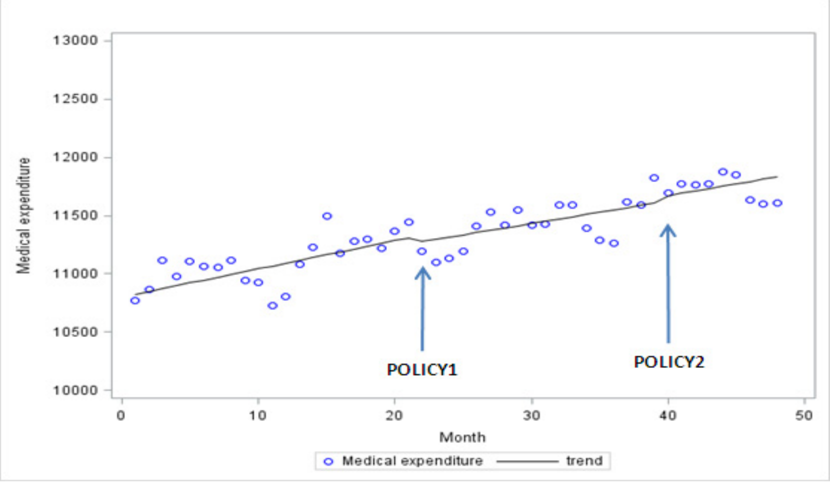
[Figure 11] Changes in medical expenditures per claim for acute URIs (children)



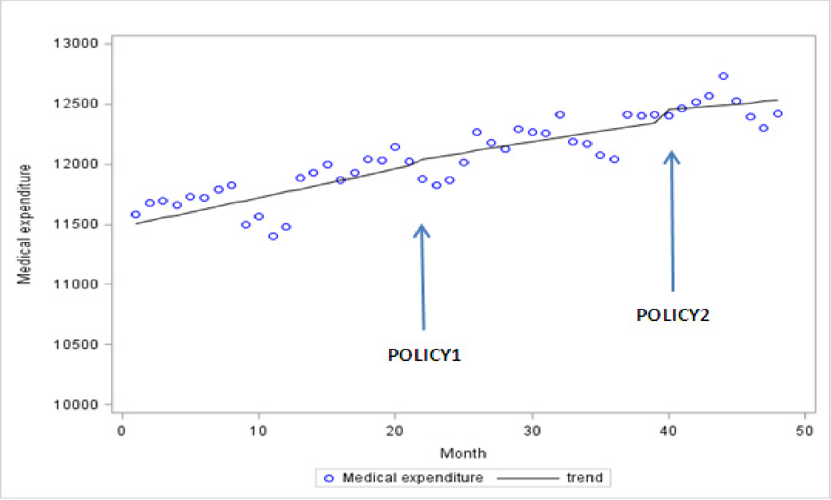
[Figure 12] Changes in medical expenditures per claim for acute URIs (adults)



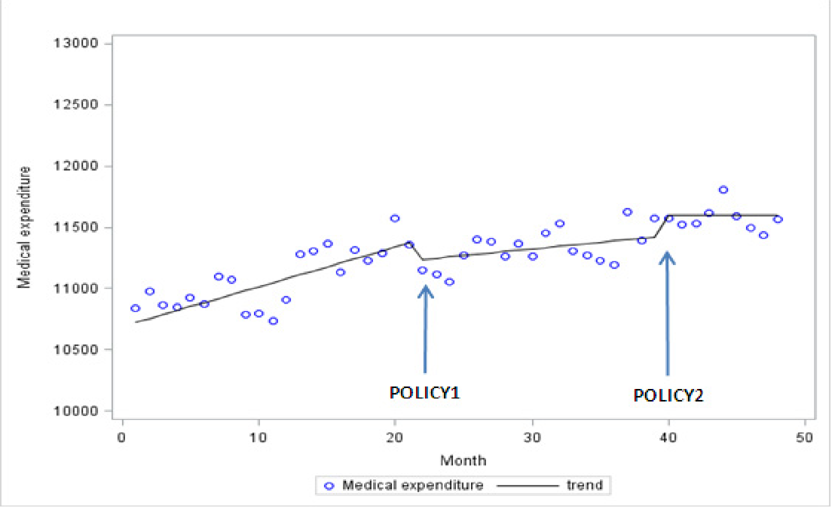
[Figure 13] Changes in medical expenditures per claim for acute LRIs (children)



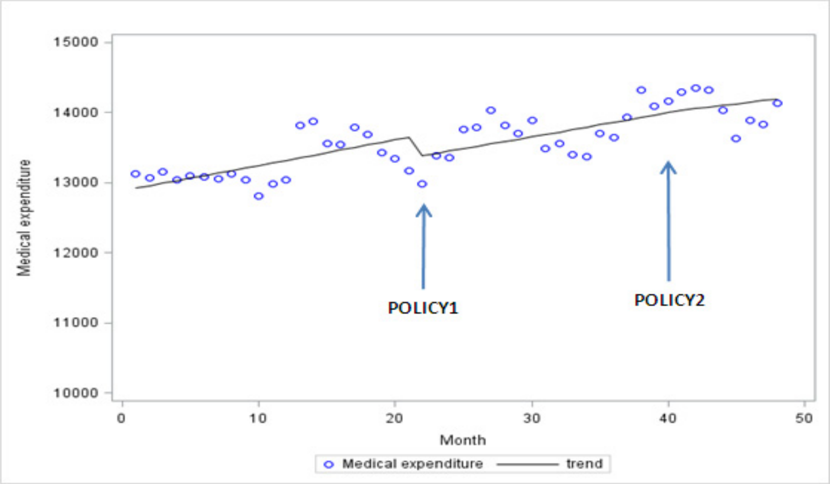
[Figure 14] Changes in medical expenditures per claim for acute LRIs (adults)



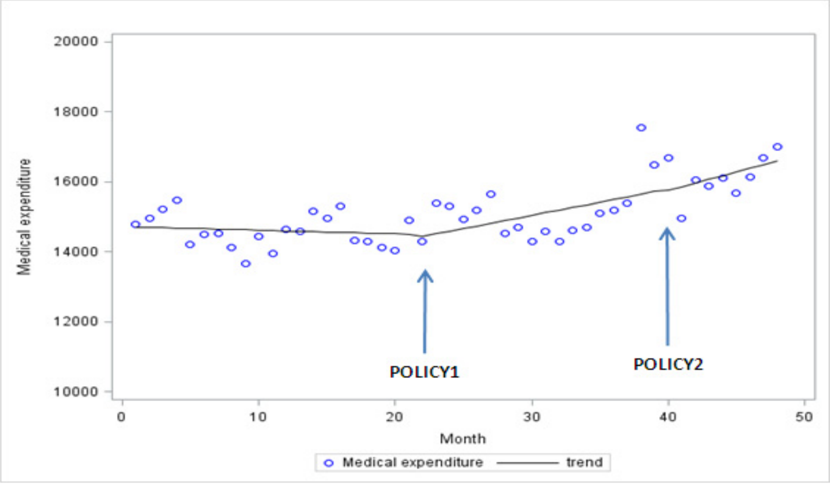
[Figure 15] Changes in medical expenditures per claim for otitis media (children)



[Figure 16] Changes in medical expenditures per claim for otitis media (adults)



[Figure 17] Changes in medical expenditures per claim for cystitis and other disorders of the urinary system (adults)



C. Antibiotic prescription rate per claim

Next, limiting our analysis to infectious diseases including acute URIs, acute LRIs, otitis media, and infections in the urinary system, we analyzed antibiotic prescription rates after dividing the research target period into two time spans: before and after the implementation of the financial incentive program in October 2010. As you can see in Table 10, antibiotic prescriptions declined slightly for all the sampled diseases after the implementation of the policy compared with those before the implementation. Antibiotic prescription rates for acute URIs in children and adults were 55.1% and 50.7%, respectively before the program was implemented, but they went down to 48.5% and 44.4%, respectively, after the implementation. In the case of otitis media (children), its antibiotic prescribing rate was the highest at 94.3% before the policy change, but it fell slightly to 93.6% after the change.

〈Table 10〉 Antibiotic prescription rates before and after policy change

(In %)

Disease	Prescribing Rates by Policy Time Span			
	January 2009–September 2010		October 2010–December 2012	
	Average	Standard Deviation	Average	Standard Deviation
Acute upper respiratory infections–children	55.1	2.8	48.5	2.3
Acute upper respiratory	50.7	2.4	44.4	2.5

Disease	Prescribing Rates by Policy Time Span			
	January 2009－September 2010		October 2010－December 2012	
	Average	Standard Deviation	Average	Standard Deviation
infections－adults				
Acute lower respiratory infections－children	70.8	1.8	67.5	1.8
Acute lower respiratory infections－adults	65.1	1.2	61.3	1.6
Otitis media－children	94.3	0.6	93.6	0.6
Otitis media-adults	88.3	1.0	87.8	0.7
Cystitis and other disorders of the urinary system－adults	93.3	0.6	92.9	0.9

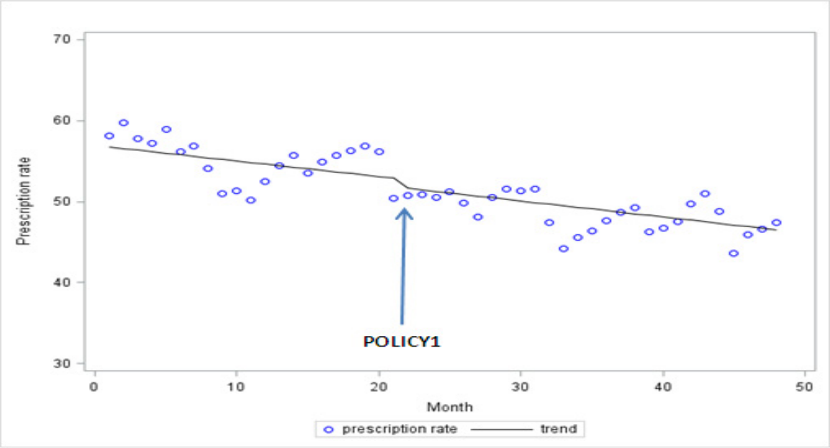
Results of an interrupted time series analysis on changes in antibiotic prescription rates before and after policy implementation indicate that financial incentives had little impact. Antibiotic prescription rates for most of the diseases had been on the decrease even before the implementation of the program (TIME1), though not statistically significant. A statistically significant downward trend was found only for otitis media (children). Financial incentives for outpatient drug prescriptions put monthly antibiotic prescription rates on the downward path for all diseases except for otitis media (children), but not by a statistically significant extent. A statistically significant trend was found only for otitis media (adults) (see Table 11).

〈Table 11〉 Results of interrupted time series analysis on antibiotic prescription rates

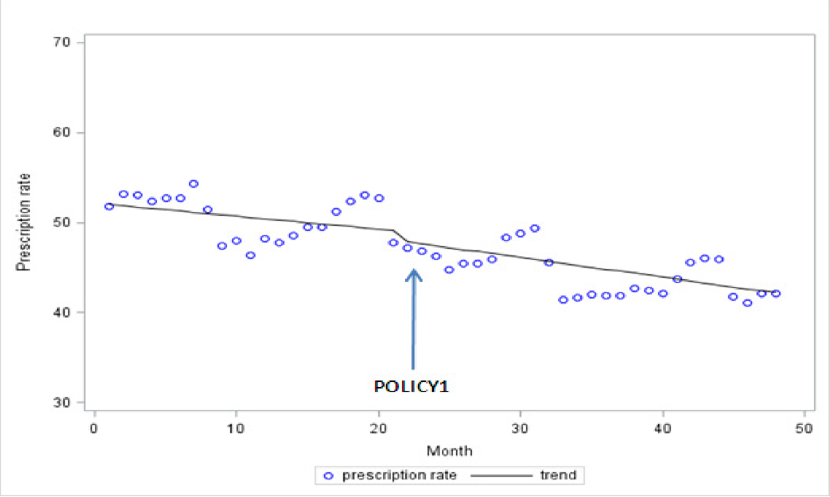
Disease (Total R^2)	Parameter	β Estimate (SE)	p
Acute upper respiratory infections－children (0.8885)	Intercept	56.9367 (2.0578)	<.0001
	TIME1	-0.1916 (0.1157)	.1054
	POLICY1	-1.0495 (1.2263)	.3971
	TIME2	-0.0062 (0.1631)	.97
Acute upper respiratory infections－adults (0.9201)	Intercept	52.152 (2.1519)	<.0001
	TIME1	-0.1437 (0.101)	0.1623
	POLICY1	-1.0293 (1.0308)	0.3238
	TIME2	-0.0754 (0.1387)	0.5898
Acute lower respiratory infections－children (0.6181)	Intercept	70.9732 (1.101)	<.0001
	TIME1	-0.0222 (0.0857)	0.7971
	POLICY1	-1.099 (1.3043)	0.4041
	TIME2	-0.107 (0.1093)	0.3331
Acute lower respiratory infections－adults (0.8735)	Intercept	65.5477 (1.1756)	<.0001
	TIME1	-0.0474 (0.0837)	0.5746
	POLICY1	-1.2219 (0.9092)	0.186
	TIME2	-0.0864 (0.1215)	0.4808
Otitis media－children (0.538)	Intercept	94.6557 (0.2162)	<.0001
	TIME1*	-0.0386 (0.0146)	0.0112
	POLICY1	0.1711 (0.1711)	0.4351
	TIME2	0.007162 (0.0186)	0.7024
Otitis media－adults (0.2404)	Intercept	87.8671 (0.3515)	<.0001
	TIME1	0.0397 (0.028)	0.1635
	POLICY1	-0.1648 (0.4491)	0.7154
	TIME2*	-0.0912 (0.0339)	0.0101
Cystitis and other disorders of the urinary system－adults (0.4474)	Intercept	93.3585 (0.4096)	<.0001
	TIME1	-0.00365 (0.0263)	0.8903
	POLICY1	0.3192 (0.3839)	0.4105
	TIME2	-0.0514 (0.0342)	0.1404

* p〈0.05, ** p〈0.01

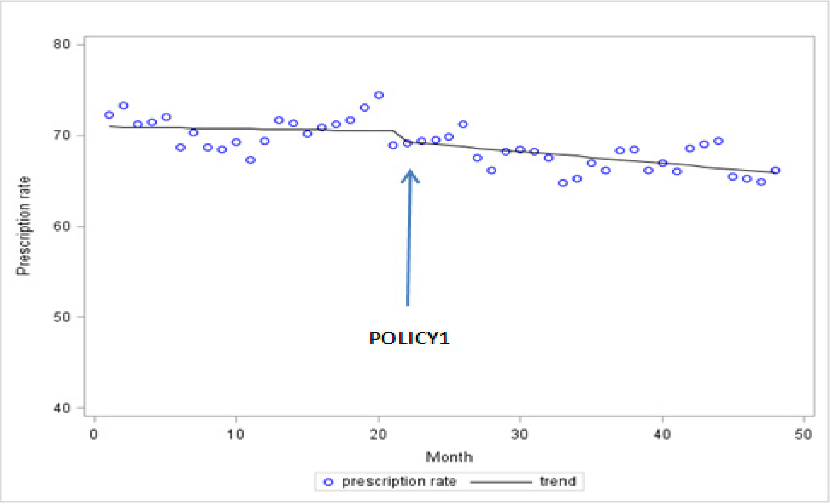
[Figure 18] Changes in antibiotic prescription rates for acute URIs (children)



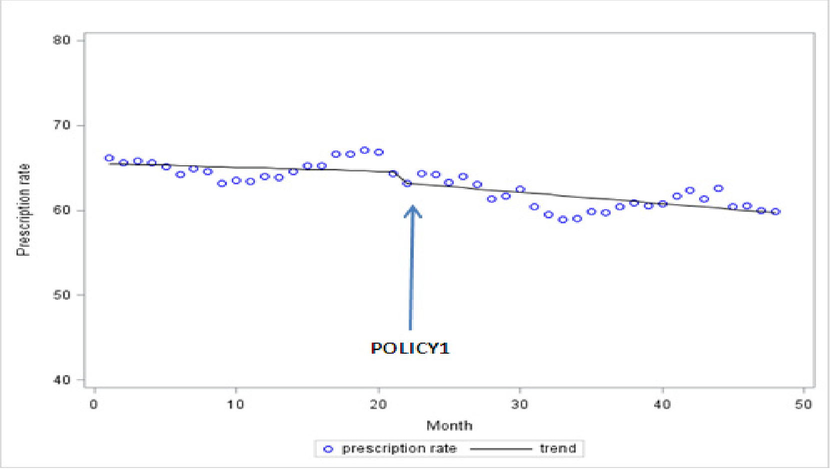
[Figure 19] Changes in antibiotic prescription rates for acute URIs (adults)



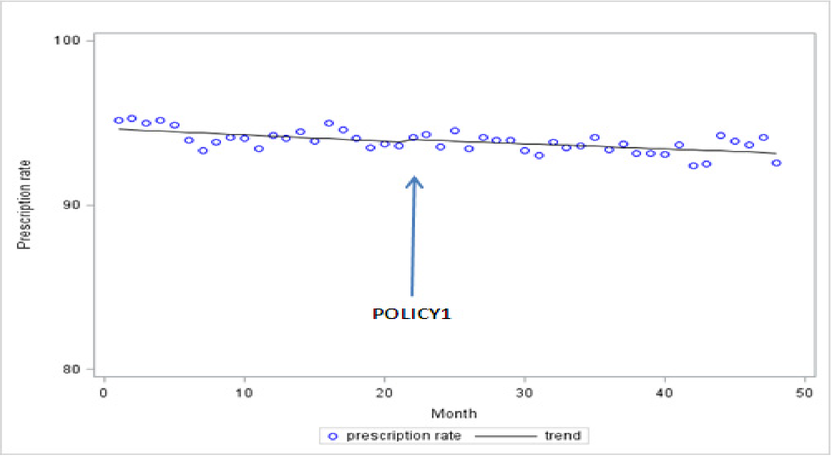
[Figure 20] Changes in antibiotic prescription rates for acute LRIs (children)



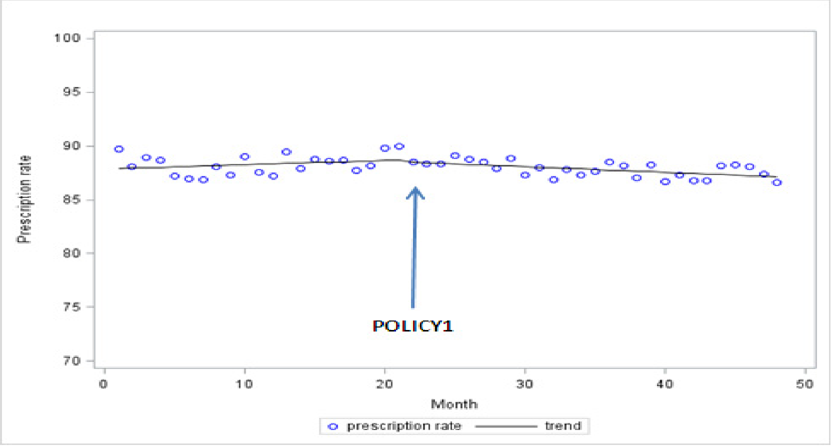
[Figure 21] Changes in antibiotic prescription rates for acute LRIs (adults)



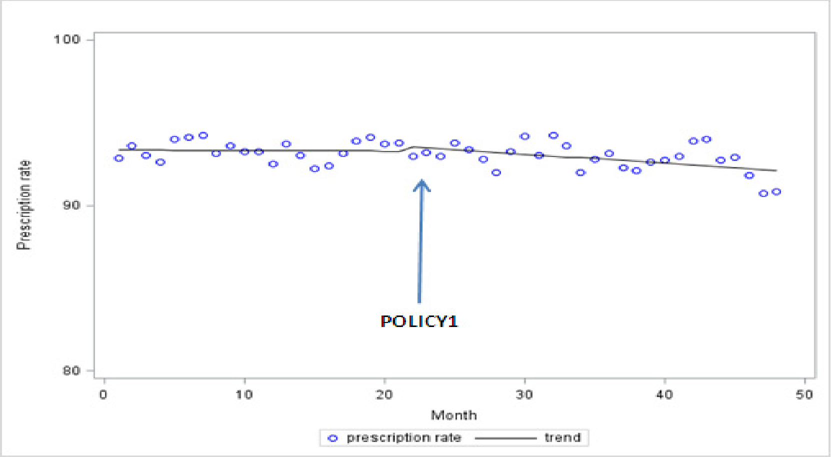
[Figure 22] Changes in antibiotic prescription rates for otitis media (children)



[Figure 23] Changes in antibiotic prescription rates for otitis media (adults)



[Figure 24] Changes in antibiotic prescription rates for cystitis and other disorders of the urinary system (adults)



D. Number of antibiotic products prescribed per claim

Table 12 shows results of calculating the number of different antibiotic products prescribed for each disease before and after October 2010. In the case of acute URIs (children, adults), acute LRIs (children) and otitis media (adults), the number of antibiotics prescribed decreased after the implementation of financial incentives for outpatient prescriptions, while it increased for acute LRIs (adults), otitis media (children), and cystitis and other disorders of the urinary system (adults).

〈Table 12〉 Number of antibiotic products prescribed per claim before and after policy change

Disease	Number of Drugs Prescribed by Policy Time Span			
	January 2009－September 2010		October 2010－December 2012	
	Average	Standard Deviation	Average	Standard Deviation
Acute upper respiratory infections－children	1.054	0.004	1.047	0.004
Acute upper respiratory infections－adults	1.119	0.008	1.116	0.007
Acute lower respiratory infections－children	1.043	0.005	1.041	0.004
Acute lower respiratory infections－adults	1.112	0.005	1.114	0.005
Otitis media－children	1.111	0.004	1.117	0.007
Otitis media－adults	1.133	0.009	1.127	0.008
Cystitis and other disorders of the urinary system－adults	1.656	0.018	1.663	0.013

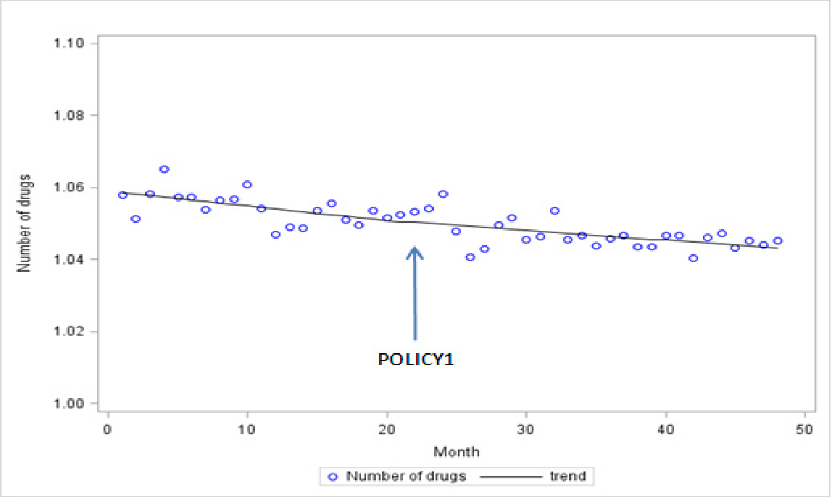
Results of performing interrupted time series analysis for the number of antibiotics prescribed differ with the diseases. In the case of otitis media (adults), incentive payments affected the number of drugs prescribed immediately and then gradually over time by leading it in the downward direction, though by a small degree, and the changes were statistically significant. As for the rest of the diseases, the policy affected them in the direction of slightly increasing the number of drugs prescribed immediately or gradually, and the effects were statistically significant for acute URIs (adults), acute LRIs (children), and infections in the urinary system (adults) (see Table 13).

〈Table 13〉 Results of interrupted time series analysis on the number of antibiotics prescribed

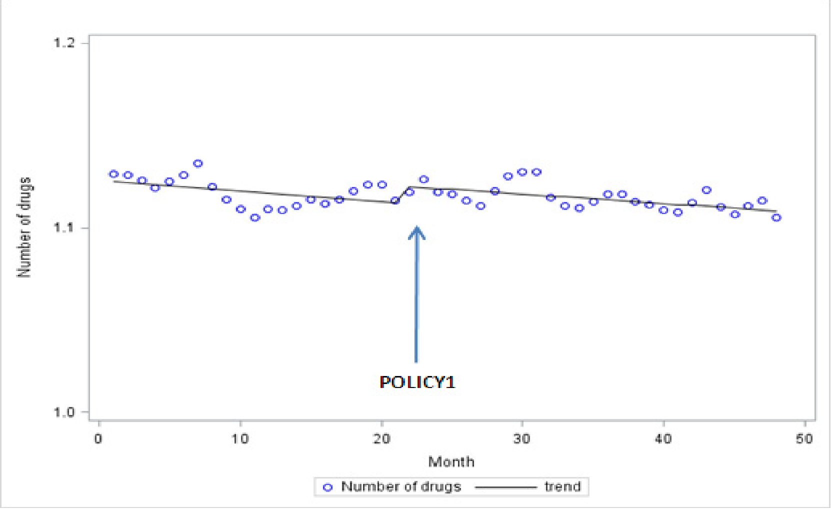
Disease (Total R^2)	Parameter	β Estimate (SE)	p
Acute upper respiratory infections－children (0.6736)	Intercept	1.059 (0.001535)	<.0001
	TIME1**	-0.000411 (0.000123)	0.0017
	POLICY1	0.000231 (0.001981)	0.9078
	TIME2	0.000136 (0.000146)	0.3561
Acute upper respiratory infections－adults (0.6506)	Intercept	1.1258 (0.003676)	<.0001
	TIME1*	-0.000577 (0.000283)	0.0477
	POLICY1*	0.009191 (0.004097)	0.0302
	TIME2	0.0000694 (0.000364)	0.8495
Acute lower respiratory infections－children (0.5276)	Intercept	1.0473 (0.001201)	<.0001
	TIME1**	-0.000382 (0.0000975)	0.0003
	POLICY1	0.003006 (0.001561)	0.0612
	TIME2**	0.000302 (0.000106)	0.0069
Acute lower respiratory infections－adults (0.2517)	Intercept	1.1174 (0.002975)	<.0001
	TIME1	-0.000425 (0.000233)	0.0757
	POLICY1	0.006102 (0.003641)	0.101
	TIME2	0.000408 (0.000293)	0.1704
Otitis media－children (0.2123)	Intercept	1.1113 (0.002658)	<.0001
	TIME1	0.0000143 (0.000212)	0.9464
	POLICY1	0.001299 (0.003395)	0.7039
	TIME2	0.000243 (0.000257)	0.3489
Otitis media－adults (0.3796)	Intercept	1.1288 (0.001992)	<.0001
	TIME1*	0.000344 (0.000162)	0.0394
	POLICY1**	-0.007548 (0.002612)	0.0061
	TIME2*	-0.00044 (0.000177)	0.0168
Cystitis and other disorders of the urinary system－adults (0.2390)	Intercept	1.6673 (0.005249)	<.0001
	TIME1*	-0.001053 (0.000425)	0.0173
	POLICY1**	0.0246 (0.006928)	0.0009
	TIME2	0.000634 (0.000487)	0.2005

* $p<0.05$, ** $p<0.01$

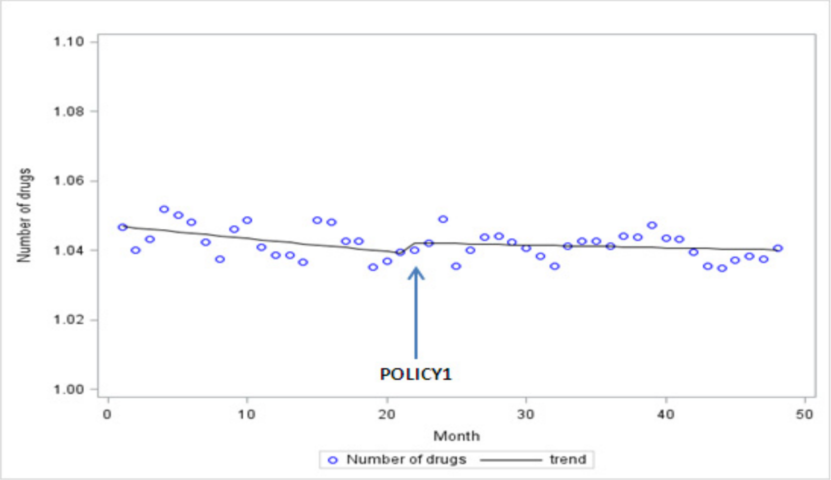
[Figure 25] Changes in the number of antibiotics prescribed for acute URIs (children)



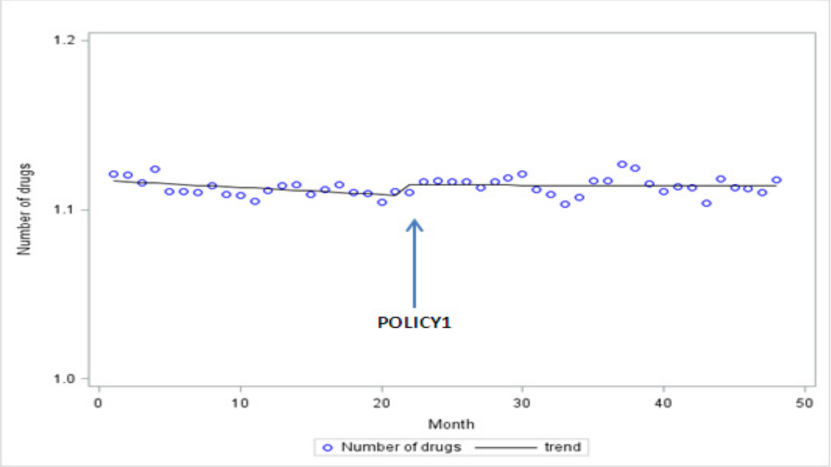
[Figure 26] Changes in the number of antibiotics prescribed for acute URIs (adults)



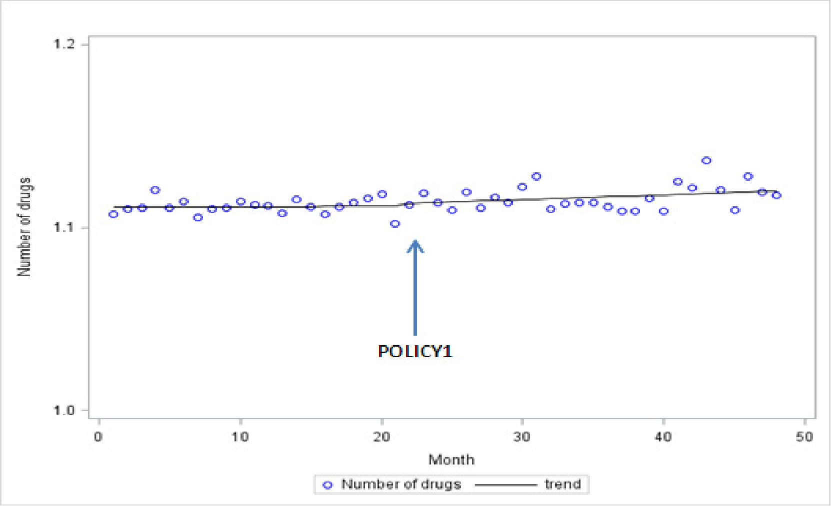
[Figure 27] Changes in the number of antibiotics prescribed for acute LRIs (children)



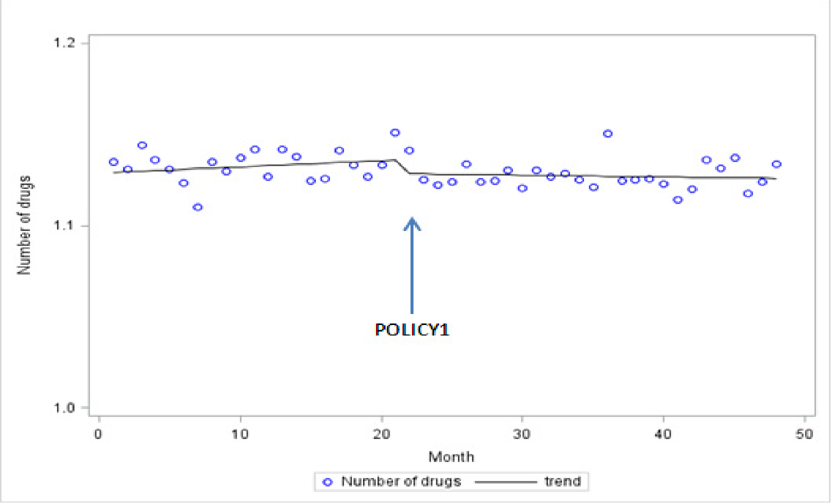
[Figure 28] Changes in the number of antibiotics prescribed for acute LRIs (adults)



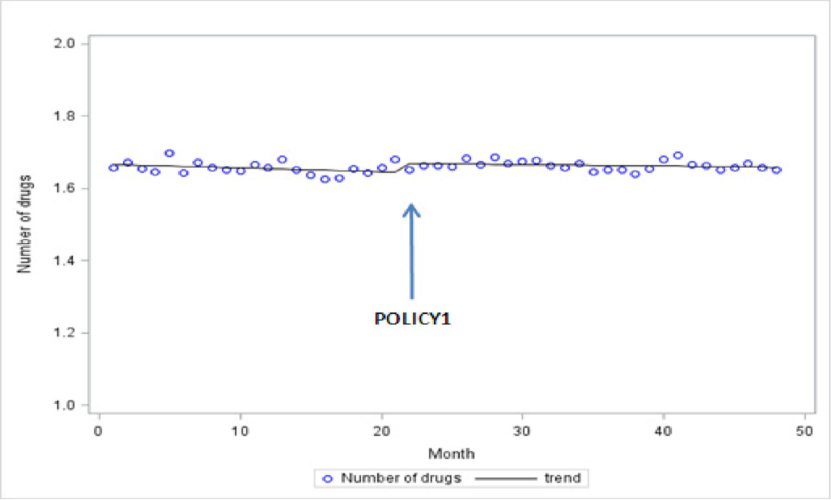
[Figure 29] Changes in the number of antibiotics prescribed for otitis media (children)



[Figure 30] Changes in the number of antibiotics prescribed for otitis media (adults)



[Figure 31] Changes in the number of antibiotics prescribed for cystitis and other disorders of the urinary system (adults)



E. Length of antibiotic administration

Table 14 presents results of calculating days of antibiotic administration before and after the implementation of financial incentives for outpatient prescriptions. The length of antibiotic administration turned out to have increased for all the sampled diseases after the implementation than before.

〈Table 14〉 Length of administration for antibiotics before and after policy change

(In days)

Disease	Length of Administration by Policy Time Span			
	January 2009 – September 2010		October 2010 – December 2012	
	Average	Standard Deviation	Average	Standard Deviation
Acute upper respiratory infections – children	2.71	0.06	2.83	0.06
Acute upper respiratory infections – adults	2.75	0.05	2.86	0.06
Acute lower respiratory infections – children	2.73	0.06	2.84	0.06
Acute lower respiratory infections – adults	2.82	0.05	2.93	0.06
Otitis media – children	2.81	0.06	2.90	0.06
Otitis media – adults	2.64	0.07	2.77	0.07
Cystitis and other disorders of the urinary system – adults	2.94	0.07	3.10	0.10

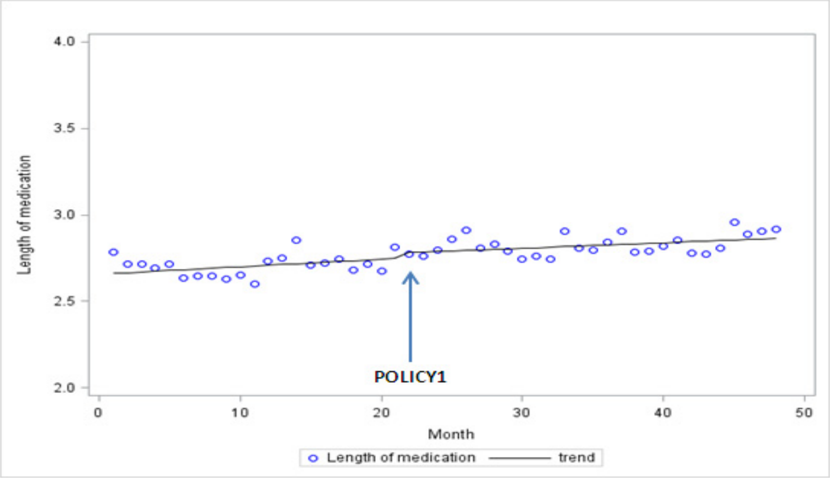
The length of antibiotic administration was on the rise for all the diseases to a statistically significant extent even before the implementation of financial incentives (TIME1). This trend was not affected by the implementation of financial incentives. In other words, an upward trend in the length of antibiotic administration can be said to have already existed independently of the implementation of the policy (see Table 15).

〈Table 15〉 Results of interrupted time series analysis on the length of administration for antibiotics

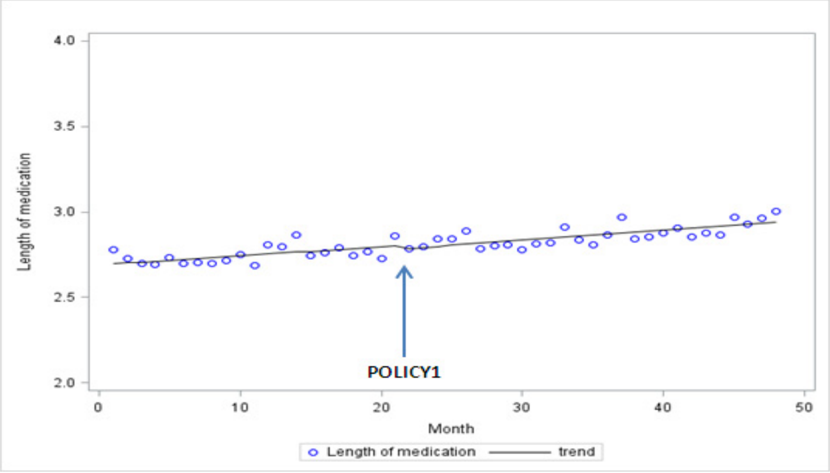
Disease (Total R^2)	Parameter	β Estimate (SE)	p
Acute upper respiratory infections－children (0.6915)	Intercept	2.6575 (0.0189)	<.0001
	TIME1**	0.004308 (0.00154)	0.0077
	POLICY1	0.0304 (0.0249)	0.2284
	TIME2	-0.001134 (0.001701)	0.5087
Acute upper respiratory infections－adults (0.7962)	Intercept	2.6907 (0.0173)	<.0001
	TIME1**	0.005258 (0.001139)	<.0001
	POLICY1	-0.0198 (0.017)	0.2507
	TIME2	0.000534 (0.001456)	0.7159
Acute lower respiratory infections－children (0.6712)	Intercept	2.6816 (0.0222)	<.0001
	TIME1*	0.003701 (0.001518)	0.019
	POLICY1	0.0336 (0.0228)	0.1482
	TIME2	-0.000156 (0.00194)	0.9362
Acute lower respiratory infections－adults (0.7492)	Intercept	2.7696 (0.018)	<.0001
	TIME1**	0.004989 (0.001431)	0.0011
	POLICY1	-0.0277 (0.023)	0.2341
	TIME2	0.000934 (0.001735)	0.5929
Otitis media－children (0.5742)	Intercept	2.7711 (0.0235)	<.0001
	TIME1*	0.003229 (0.001599)	0.0496
	POLICY1	0.0464 (0.0241)	0.0608
	TIME2	-0.001837 (0.002039)	0.3726
Otitis media－adults (0.7845)	Intercept	2.5605 (0.017)	<.0001
	TIME1**	0.007321 (0.001383)	<.0001
	POLICY1	-0.024 (0.0222)	0.2861
	TIME2	-0.001593 (0.001523)	0.3013
Cystitis and other disorders of the urinary system－adults (0.7812)	Intercept	2.865 (0.0255)	<.0001
	TIME1**	0.007073 (0.002034)	0.0012
	POLICY1	-0.0539 (0.0326)	0.1058
	TIME2	0.003018 (0.002467)	0.2276

* p〈0.05, ** p〈0.01

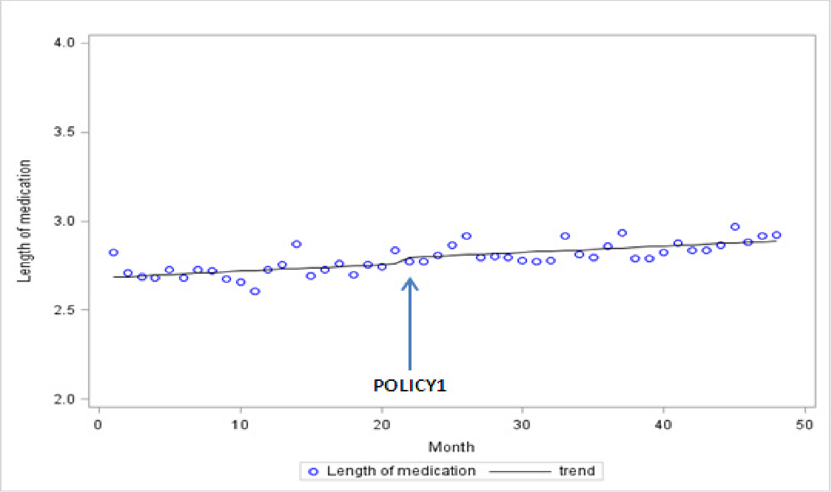
[Figure 32] Changes in the length of antibiotic administration for acute URIs (children)



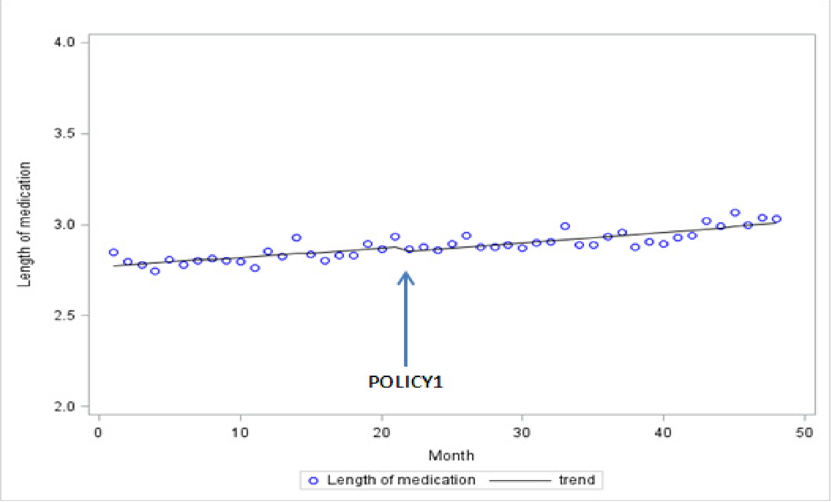
[Figure 33] Changes in the length of antibiotic administration for acute URIs (adults)



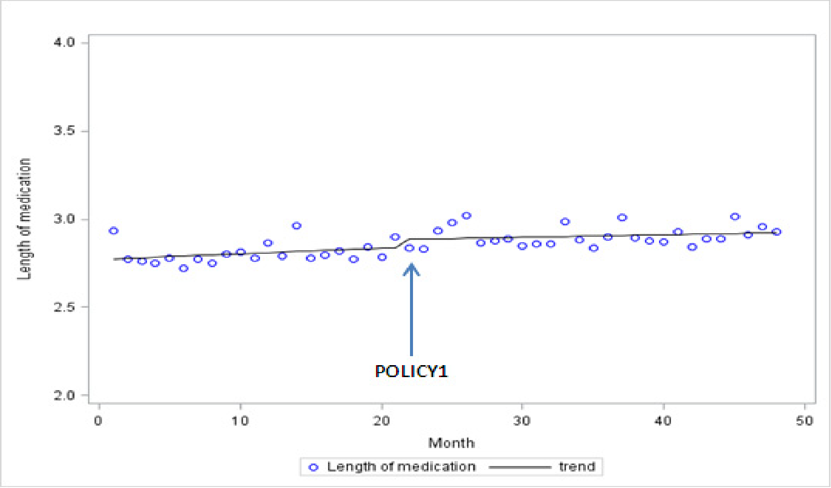
[Figure 34] Changes in the length of antibiotic administration for acute LRIs (children)



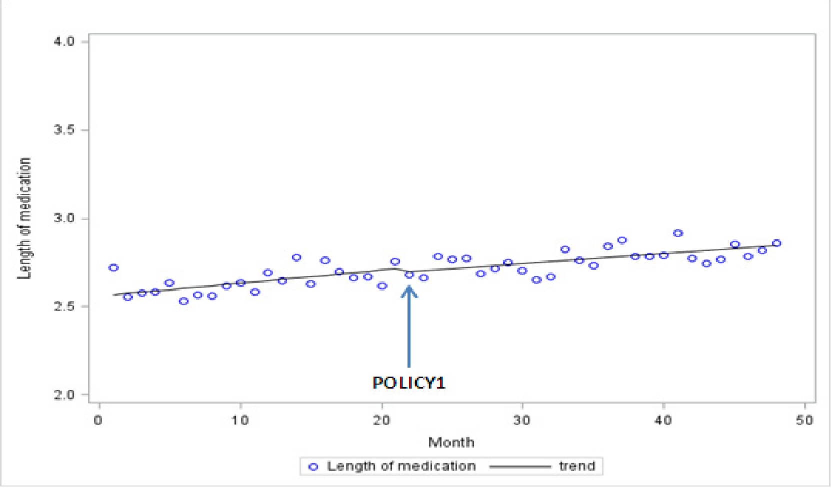
[Figure 35] Changes in the length of antibiotic administration for acute LRIs (adults)



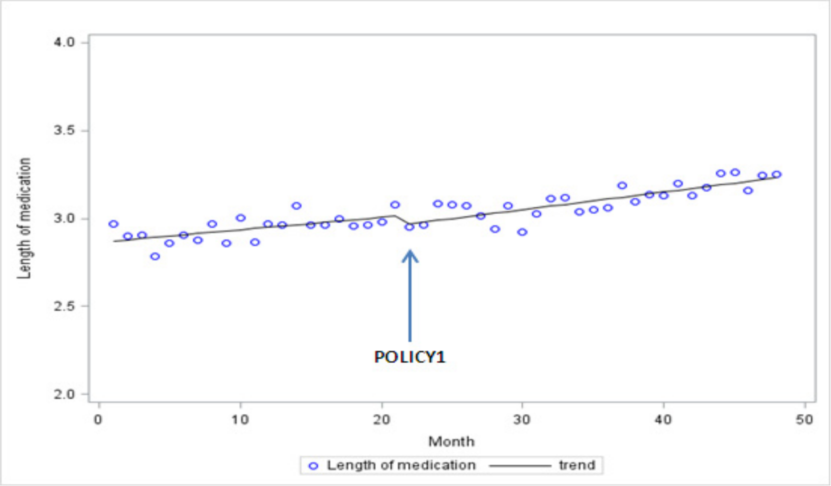
[Figure 36] Changes in the length of antibiotic administration for otitis media (children)



[Figure 37] Changes in the length of antibiotic administration for otitis media (adults)



[Figure 38] Changes in the length of antibiotic administration for cystitis and other disorders of the urinary system (adults)



F. Antibiotic injection prescription rates

According to Table 16, antibiotic injection prescription rates decreased slightly for all the diseases after October 2010. The percentage of injectable antibiotics is the lowest for acute URIs (children), while it is the highest for cystitis and other disorders of the urinary system (adults).

〈Table 16〉 Antibiotic injection prescription rates before and after policy change

(In %)

Disease	Injection Prescribing Rates by Policy Time Span			
	January 2009—September 2010		October 2010—December 2012	
	Average	Standard Deviation	Average	Standard Deviation
Acute upper respiratory infections—children	2.92	0.50	1.91	0.36
Acute upper respiratory infections—adults	9.59	0.76	8.13	0.72
Acute lower respiratory infections—children	3.11	0.64	2.52	0.36
Acute lower respiratory infections—adults	11.22	0.71	10.71	0.62
Otitis media—children	1.65	0.45	1.28	0.24
Otitis media—adults	14.91	1.04	13.95	0.88
Cystitis and other disorders of the urinary system—adults	66.03	1.56	64.53	1.45

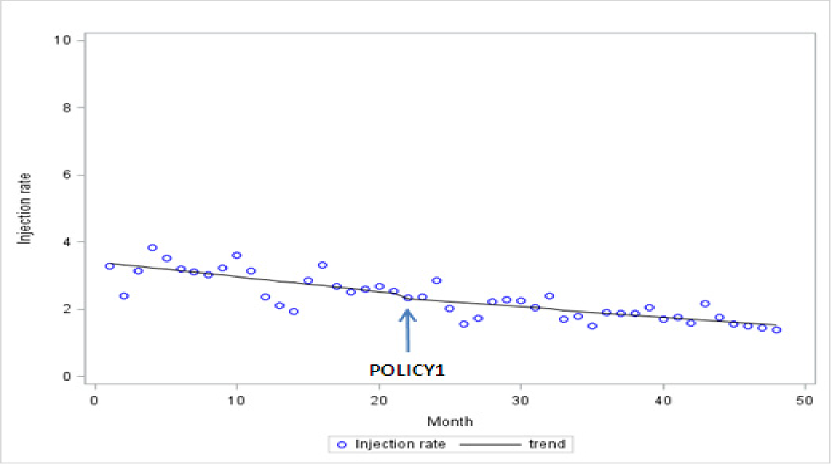
Table 17 shows results of interrupted time series analysis for percentages of injections in antibiotic prescriptions. The percentages had been on the decrease for all the diseases except for otitis media (adults) before the outpatient prescription incentive program was introduced (TIME1), and the trends were statistically significant for acute URIs (children, adults) and acute LRIs (adults). The introduction of financial incentives had a significant impact only on otitis media (adults), for which the antibiotic injection prescription rate decreased by 1.3 pp (percentage point) immediately after the implementation (POLICY1).

〈Table 17〉 Results of interrupted time series analysis on antibiotic injection prescription rates

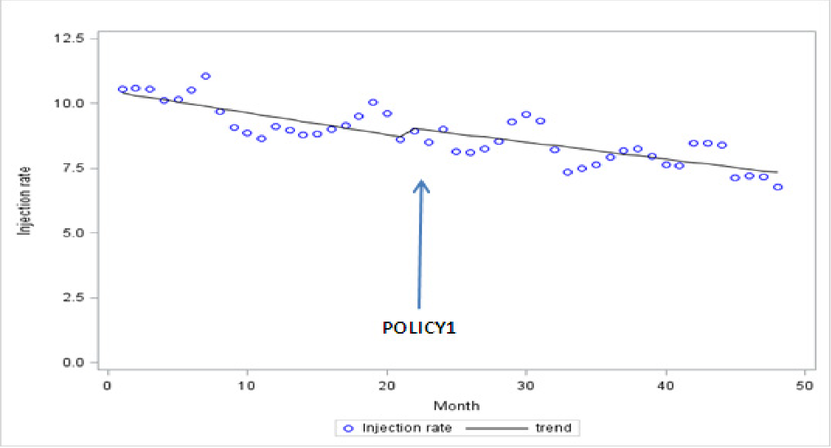
Disease (Total R^2)	Parameter	β Estimate (SE)	p
Acute upper respiratory infections–children (0.7803)	Intercept	3.4166 (0.1958)	<.0001
	TIME1**	-0.0447 (0.0133)	0.0017
	POLICY1	-0.1522 (0.1975)	0.4453
	TIME2	0.0156 (0.0172)	0.3696
Acute upper respiratory infections–adults (0.8568)	Intercept	10.4781 (0.4096)	<.0001
	TIME1**	-0.0841 (0.021)	0.0003
	POLICY1	0.382 (0.2867)	0.1898
	TIME2	0.0189 (0.0273)	0.4925
Acute lower respiratory infections–children (0.5138)	Intercept	3.4468 (0.2625)	<.0001
	TIME1	-0.0271 (0.0173)	0.1236
	POLICY1	-0.1682 (0.2546)	0.5124
	TIME2	0.0129 (0.0223)	0.5681
Acute lower respiratory infections–adults (0.6047)	Intercept	12.085 (0.475)	<.0001
	TIME1*	-0.0733 (0.035)	0.0425
	POLICY1	0.3189 (0.4564)	0.4884
	TIME2	0.0629 (0.0485)	0.2018
Otitis media–children (0.3105)	Intercept	1.9077 (0.1527)	<.0001
	TIME1	-0.0232 (0.0122)	0.0632
	POLICY1	-0.0058 (0.1951)	0.9764
	TIME2	0.0132 (0.0147)	0.3749
Otitis media–adults (0.2207)	Intercept	14.5516 (0.4386)	<.0001
	TIME1	0.0327 (0.0349)	0.3538
	POLICY1*	-1.3006 (0.5603)	0.025
	TIME2	-0.0317 (0.0423)	0.4575
Cystitis and other disorders of the urinary system–adults (0.4713)	Intercept	66.522 (0.5658)	<.0001
	TIME1	-0.0447 (0.0451)	0.3267
	POLICY1	0.9381 (0.7229)	0.2011
	TIME2	-0.0976 (0.0546)	0.0809

* $p<0.05$, ** $p<0.01$

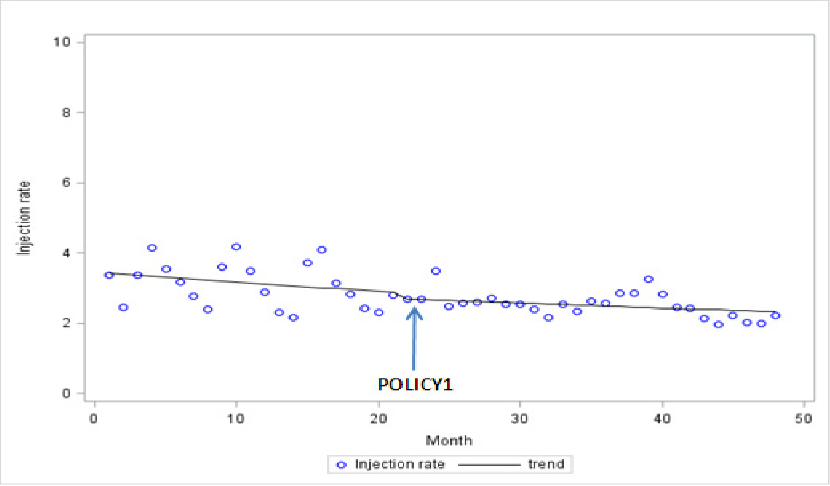
[Figure 39] Changes in antibiotic injection prescription rates for acute URIs (children)



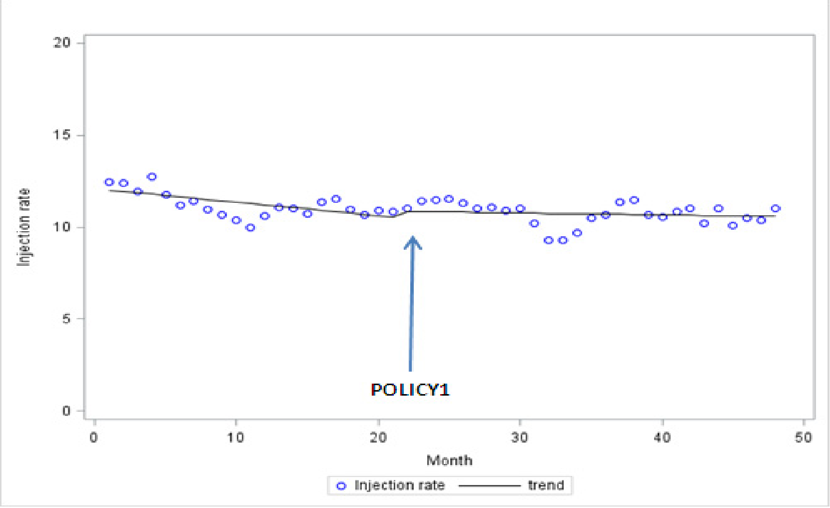
[Figure 40] Changes in antibiotic injection prescription rates for acute URIs (adults)



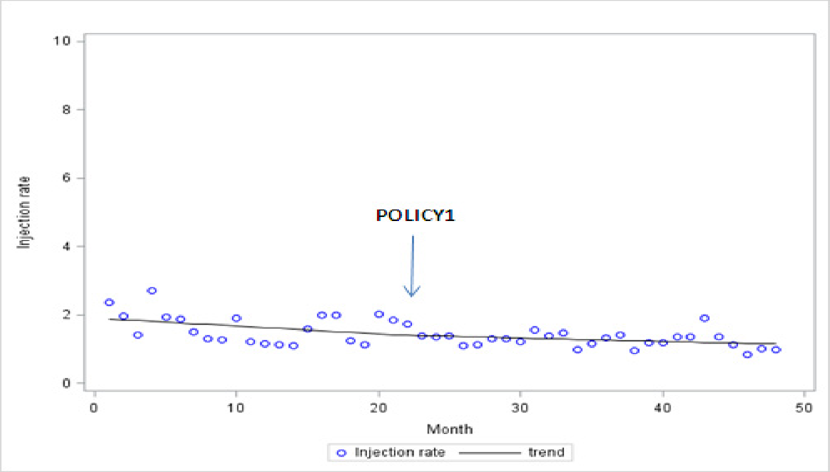
[Figure 41] Changes in antibiotic injection prescription rates for acute LRIs (children)



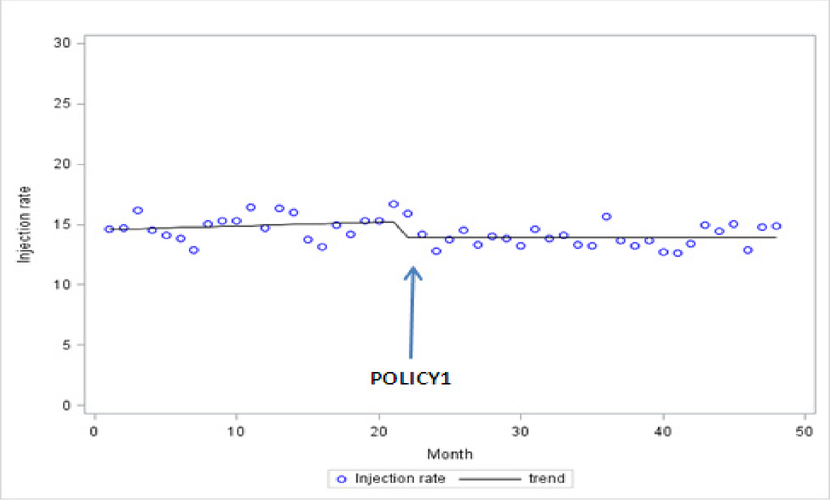
[Figure 42] Changes in antibiotic injection prescription rates for acute LRIs (adults)



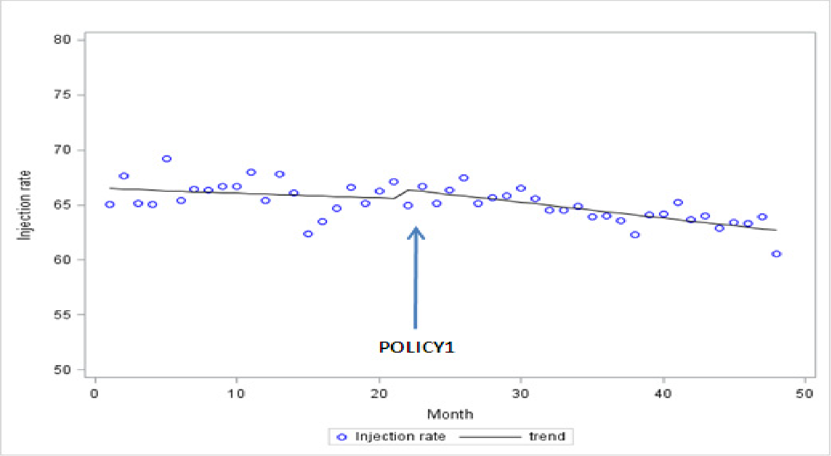
〔Figure 43〕 Changes in antibiotic injection prescription rates for otitis media (children)



〔Figure 44〕 Changes in antibiotic injection prescription rates for otitis media (adults)



[Figure 45] Changes in antibiotic injection prescription rates for cystitis and other disorders of the urinary system (adults)



G. High-priced antibiotic prescription rates

Table 18 shows results of calculating the rates of prescribing high-priced items in antibiotic prescriptions after dividing the four-year period into three time spans: before and after the implementation of the financial incentive program in October 2010 and the across-the-board mark-down of drug prices in April 2012. Compared with the period before the implementation of financial incentives, the percentages of high-priced antibiotic prescriptions decreased for all the diseases after the implementation. After April 2012, the declining percentages of high-priced drug prescriptions started to rise again for all the diseases except for acute URIs (adults) and infections in the urinary system (adults).

〈Table 18〉 High-priced antibiotic prescription rates before and after policy change

(In %)

Disease	High-Priced Drug Prescription Rates by Policy Time Span					
	January 2009－September 2010		October 2010－March 2012		April 2012－December 2012	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
Acute upper respiratory infections－children	5.58	0.59	4.65	0.35	5.12	0.32
Acute upper respiratory infections－adults	4.93	0.24	4.43	0.23	4.56	0.14
Acute lower respiratory infections－children	8.56	0.79	7.04	0.57	7.54	0.25
Acute lower respiratory infections－adults	5.71	0.22	5.16	0.42	4.82	0.19
Otitis media－children	17.69	2.84	15.70	0.90	25.40	1.21
Otitis media－adults	7.41	0.74	7.25	0.75	9.63	0.89
Cystitis and other disorders of the urinary system－adults	7.40	0.90	7.28	1.05	6.76	0.65

Table 19 shows results of interrupted time series analysis of high-priced antibiotic prescription rates. High-priced drug prescriptions for acute URIs (children), acute LRIs (children, adults) and otitis media (children) showed a statistically significant downward trend even before October 2010 (TIME1). The implementation of the incentive program led the percentage of high-priced antibiotic prescriptions for otitis media (children) to grow by 0.2571 percentage point a month. On the contrary, the percentage went down by 0.3671 percentage point for acute UTRIs (adults) immediately after the implementation. The program also affected acute LRIs (adults) and cystitis and other disorders of the urinary system (adults): The monthly trend of high-priced antibiotic prescription rates fell by 0.0437 percentage point and 0.1399 percentage point, respectively. Right after the drug price cut, high-priced antibiotic prescriptions significantly increased for acute LRIs (children) and otitis media (children, adults).

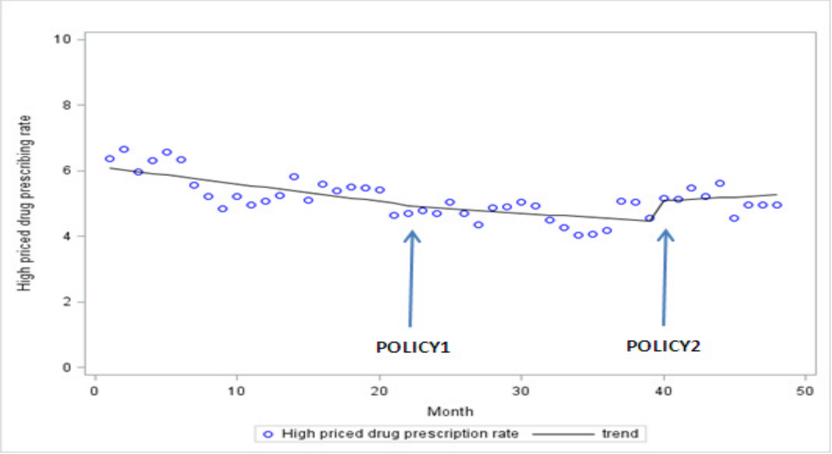
〈Table 19〉 Results of an interrupted time series analysis on high-priced antibiotic prescription rates

Disease (Total R^2)	Parameter	β Estimate (SE)	p
Acute upper respiratory infections－children (0.7678)	Intercept	6.1343 (0.2663)	<.0001
	TIME1**	-0.0535 (0.014)	0.0004
	POLICY1	-0.0678 (0.2109)	0.7496
	TIME2	0.0272 (0.0214)	0.2101
	POLICY2	0.5969 (0.3446)	0.091
	TIME3	0.0487 (0.058)	0.4062
Acute upper respiratory infections－adults (0.7873)	Intercept	5.0396 (0.1492)	<.0001
	TIME1	-0.0121 (0.007)	0.0924
	POLICY1**	-0.3671 (0.1067)	0.0014
	TIME2	0.0186 (0.0107)	0.0903
	POLICY2	-0.1065 (0.1797)	0.5567
	TIME3	0.015 (0.029)	0.6089
Acute lower respiratory infections－children (0.7812)	Intercept	9.5216 (0.3761)	<.0001
	TIME1**	-0.0828 (0.0289)	0.0065
	POLICY1	-0.0595 (0.4471)	0.8948
	TIME2	0.008035 (0.0491)	0.8708
	POLICY2*	1.2847 (0.5219)	0.0181
	TIME3	0.0569 (0.1007)	0.575

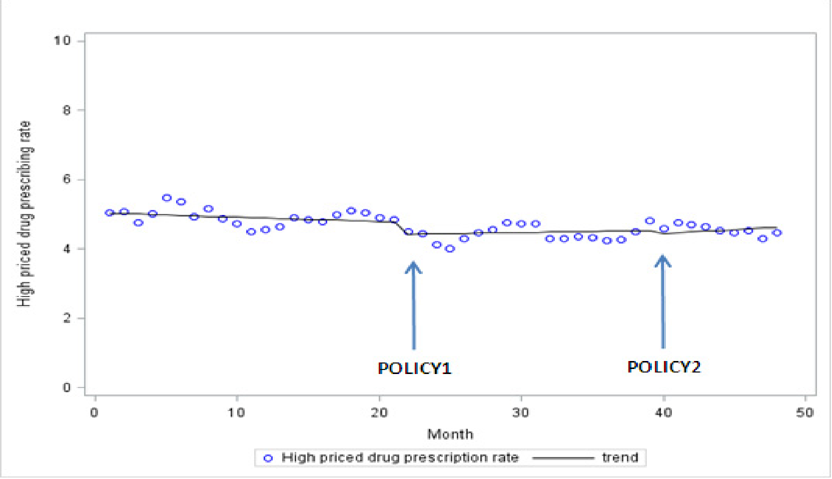
Disease (Total R^2)	Parameter	β Estimate (SE)	p
Acute lower respiratory infections－adults (0.8145)	Intercept	5.9253 (0.0853)	<.0001
	TIME1**	-0.0198 (0.007)	0.0074
	POLICY1	0.2274 (0.1406)	0.1135
	TIME2**	-0.0437 (0.0107)	0.0002
	POLICY2	0.2948 (0.2185)	0.1848
	TIME3	0.0627 (0.0336)	0.069
Otitis media－children (0.9081)	Intercept	21.3263 (0.9701)	<.0001
	TIME1**	-0.3285 (0.0752)	<.0001
	POLICY1	1.9357 (1.2113)	0.1177
	TIME2*	0.2571 (0.1262)	0.0481
	POLICY2**	10.2848 (1.4376)	<.0001
	TIME3	0.039 (0.2697)	0.8857
Otitis media－adults (0.7114)	Intercept	7.4828 (0.2661)	<.0001
	TIME1	-0.00726 (0.0218)	0.7407
	POLICY1	0.4767 (0.4226)	0.2659
	TIME2	-0.0441 (0.0334)	0.1937
	POLICY2**	1.967 (0.6739)	0.0057
	TIME3	0.2077 (0.1065)	0.0582
Cystitis and other disorders of the urinary system－adults (0.4173)	Intercept	7.1646 (0.3418)	<.0001
	TIME1	0.0211 (0.027)	0.439
	POLICY1	0.8051 (0.4944)	0.1113
	TIME2**	-0.1399 (0.0434)	0.0025
	POLICY2	0.8849 (0.6781)	0.1994
	TIME3	0.0252 (0.1136)	0.8254

* $p<0.05$, ** $p<0.01$

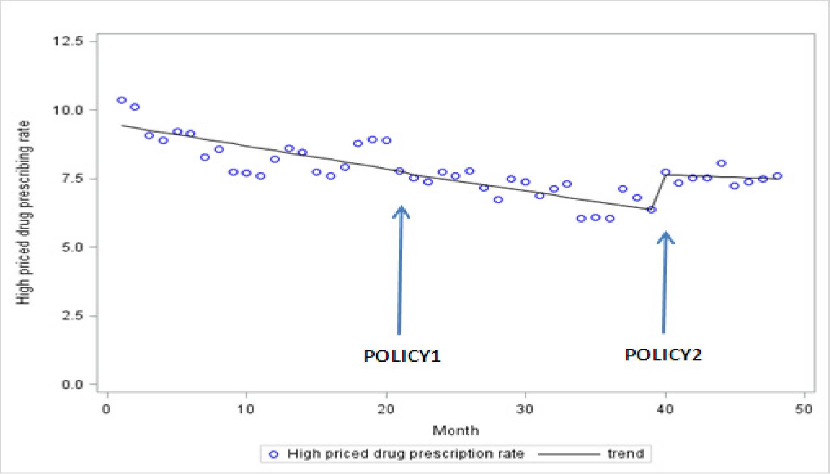
[Figure 46] Changes in high-priced antibiotic prescription rates for acute URIs (children)



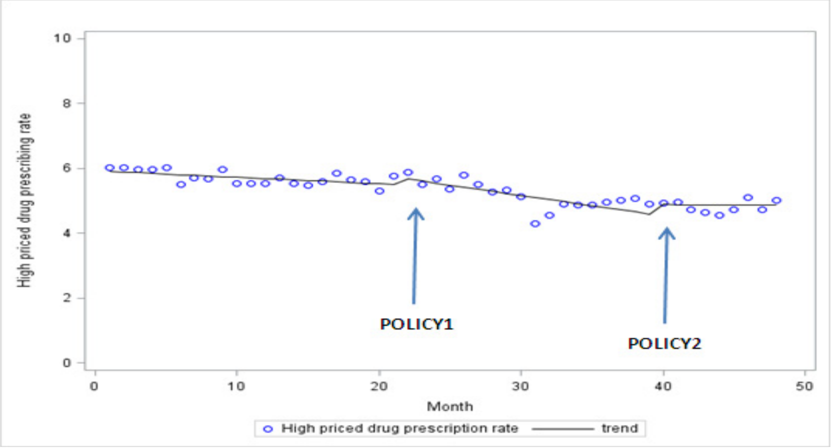
[Figure 47] Changes in high-priced antibiotic prescription rates for acute URIs (adults)



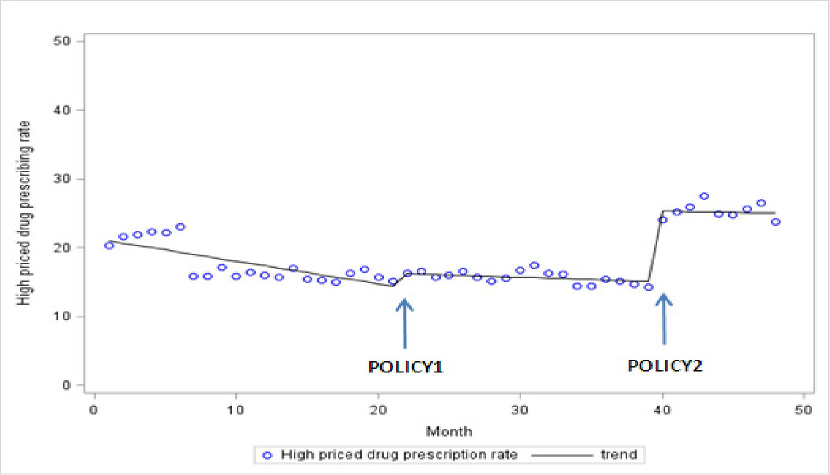
[Figure 48] Changes in high-priced antibiotic prescription rates for acute LRIs (children)



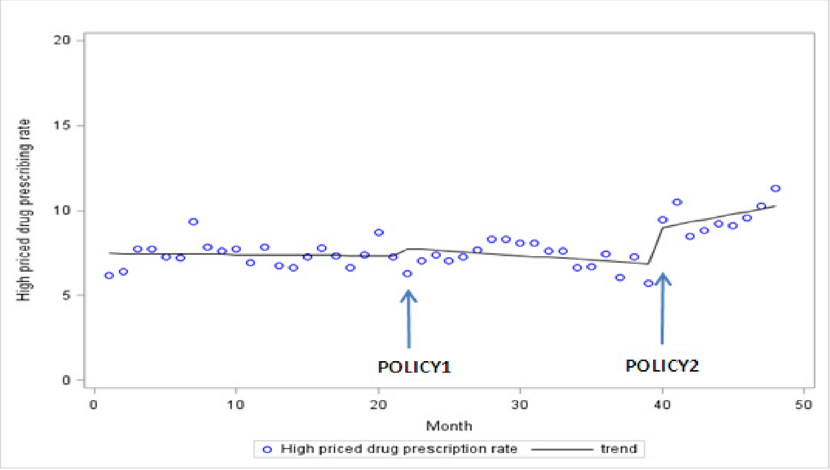
[Figure 49] Changes in high-priced antibiotic prescription rates for acute LRIs (adults)



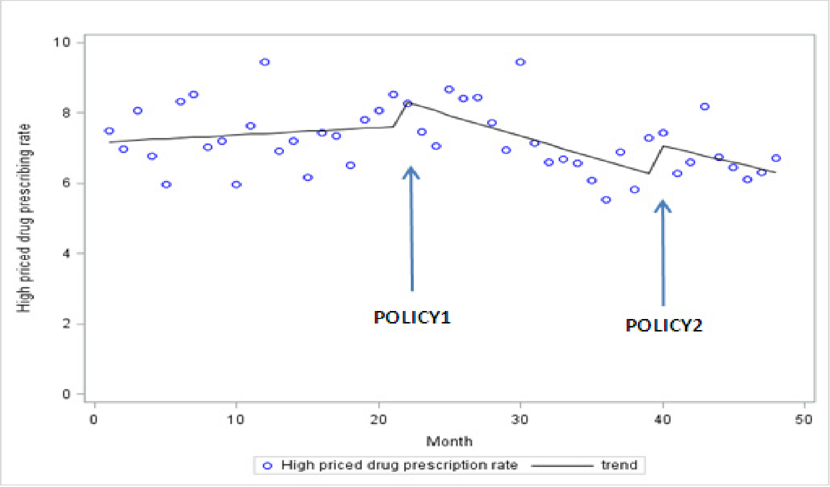
[Figure 50] Changes in high-priced antibiotic prescription rates for otitis media (children)



[Figure 51] Changes in high-priced antibiotic prescription rates for otitis media (adults)



[Figure 52] Changes in high-priced antibiotic prescription rates for cystitis and other disorders of the urinary system (adults)



Chapter 4
Discussion

4 Discussion

This study analyzed and evaluated the effects of two policies put into force for the purpose of reducing pharmaceutical expenditures, which is one of the biggest policy tasks of the National Health Insurance System in the pharmaceutical field, on doctors' prescribing behaviors. The two policies were planned and executed targeting drug prices and volumes—the two factors affecting the size of pharmaceutical spending—respectively, and their respective effects on the common goal of pharmaceutical cost savings can be compared and discussed.

The financial incentive program that went into force in October 2010 is the first policy in Korea that seeks to cut down on the consumption of medical supplies through financial incentives for doctors, who are key decision makers in drug prescriptions. It is very meaningful in that it is a volume-driven policy unlike the past approaches to NHIS pharmaceutical spending oriented toward price control. In other words, the key question in policy evaluation will be whether doctors as prescribing decision makers will change their prescribing practices when provided with a financial incentive for reduction in the quantity of medication that they prescribe.

On the other hand, the across-the-board price cut policy was carried out to lower the prices of all the drugs available on the market with an administrative means. It is expected to have impact on pharmaceutical spending, and a major policy concern will be how long the effects will last or whether it will affect prescribing practices.

1. Discussion on Methods

To assess the effects of the financial incentive program and the across-the-board mark-down of drug prices implemented in October 2010 and April 2012, respectively, this study analyzed the data of national health insurance claims and medication prescriptions for four years between 2009 and 2012. We maintained consistency in the sample by limiting the analysis data to 1,625 clinics that have not changed in status for four years.

To analyze changes in prescribing patterns relative to policy changes, this study intended to ensure representation by using frequent diseases among outpatients and divided each of three infectious disease groups into two subgroups by separating child patients from adults, considering the fact that treatment patterns for child patients are different from those for adults.

In our analysis of prescribing behaviors, we first analyzed per-claim pharmaceutical expenditures on outpatient treatments for each disease and evaluated whether the two policies exerted impact on efforts to achieve their policy goal, pharmaceutical cost savings. After that, we analyzed changes in the rest of the expenses incurred by outpatients, the medical expenditures, in order to confirm whether there are any balloon effects that cost savings achieved by decreasing pharmaceutical spending are offset by increasing medical expenditures. It has been pointed out that, if an incentive is offered with the goal of reducing the portion of pharmaceutical expenses only of all the components of the overall medical expenditure, it may distort doctors' prescribing behaviors and ultimately increase total medical expenditures (Walley & Mossialos, 2004). From this perspective, this study included not only pharmaceutical expenditures but also medical expenditures in its analysis.

Next, we analyzed changes in antibiotic prescription patterns following policy implementation, focusing on infectious diseases. Antibiotic prescription rates are managed through regular monitoring as part of the retrospective Drug Utilization Review System. Recently, however, the trend of change has been weakening, which proves that the monitoring and feedback approach has a limited impact on prescribing behaviors. The financial incentive program can motivate doctors to change their behaviors through an inducement in the form of financial incentives. This study could evaluate whether introducing a financial incentive scheme under the circumstances of continuous monitoring and feedback could bring about changes in antibiotic prescription patterns. We analyzed various aspects of prescribing including the number of antibiotic drugs prescribed, the length of antibiotic administration, the percentage of injectable antibiotics prescribed and the percentage of high-priced drugs prescribed as well as antibiotic prescription rates.

In this study, we performed interrupted time series analysis by compressing NHIS claims data into monthly data before and after policy changes in the pharmaceutical field to analyze the policy effects on drug prescriptions. Since an interrupted time series analysis can reflect tendencies before a policy change, we can overcome the limitations inherent in the simple comparison of trends before and after policy change. Diverse attempts for pharmaceutical control in the national health insurance area have been made since 2001, and the retrospective Drug Utilization Review System in particular directly monitors the prescribing indicators adopted in this study. Therefore, correction must be made to the tendencies that emerged before the policies to be evaluated in this study were implemented. By performing an interrupted time series analysis, this study could reflect such prior tendencies to analyze policy effects. Also, by separately analyzing immediate effects and monthly trends following policy implementation, we could assess the immediate and continuous effects of each of the policies to control the volumes and prices of drugs.

2. Discussion on Results

A. Effects of financial incentives and across-the-board price cuts on pharmaceutical and medical expenditures per claim

This study confirms that the introduction of the financial incentive program affected pharmaceutical spending per claim for the target diseases in the direction of steady reduction, although it did not produce immediate changes. As a result of our analyses, monthly trend of pharmaceutical spending per claim fell by 122 won for gastric ulcers and gastroesophageal reflux diseases (adults), while it went down by 28 won for acute upper respiratory infections among both children and adults. For acute lower respiratory infections (children, adults) and otitis media (children, adults) as well as infections in the cystitis and other disorders of the urinary system (adults), monthly trend of pharmaceutical spending per claim has decreased by 24 won at minimum to 41 won at maximum. These results can be said to prove that the goal of the policy—reducing the volume of drugs prescribed—has been achieved in reality. When the goal of the policy is to lead doctors to change their prescribing practices, it is desirable for the impact to be continuous rather than short-term. The results of analysis in this study confirm that the financial incentive program has a continuous effect of bringing down pharmaceutical spending.

Drug price cuts carried out in April 2012 exerted a direct impact on pharmaceutical expenditures, pulling them down immediately. In the case of gastric ulcers and GERDs (adults), pharmaceutical spending per claim dropped by 3,477 won immediately after the prices were cut across the board. It decreased by 572 won and 1,264 won for URIs (children) and otitis media (children), respectively, while it dropped by 1,828 won for cystitis and other disorders of the urinary system (adults).

However, pharmaceutical expenditures showed a tendency of gradual increase over time after the mark-down. For gastric ulcers and GERDs (adults), monthly trend of pharmaceutical spending increased by 120 won a month, whereas it rose by 37 won and 52 won for URIs (children) and otitis media (children), respectively. Steady increases in pharmaceutical expenditures after the mark-down may be due to increases in use of medications or shifts to a new product or another higher-priced product. The results of this study indicate that the price mark-down policy does have a definite impact in the short term but that it is hard to maintain continuity in policy effects over the long term, which is consistent with tendencies in other countries (Carone et al., 2012, p.33).

We analyzed the effects of the drug policies on medical expenditures, another component of the overall medical expenses for outpatients. Results show that neither financial incentives nor price cuts have a statistically significant impact on medical expenditures for most of the diseases. The only disease that showed a significant policy effect in our interrupted time series analysis of monthly data is otitis media (children): The medical expenditure for it showed a downward trend since the implementation of the financial incentive program. That is, based on the results of our analysis, it can be said that there was no balloon effect in which doctors increased other medical services while reducing drug prescriptions after the implementation of the financial incentive program.

B. Effects of financial incentives and price cuts on aspects of antibiotic prescriptions

The effects of policy changes were analyzed using the antibiotic prescription rate, number of prescribed antibiotics, length of antibiotic administration, percentage of antibiotic injection prescription and percentage of high-priced antibiotic prescription per claim for each disease as dependent variables, but no distinct effects were observed. According to the interrupted time series analysis of the monthly data, it was found that the outpatient prescription incentive program had little impact on the percentages of antibiotic prescriptions, except for otitis media (adults) for which the antibiotic prescription rate had been on a steady decrease since the implementation of the financial incentive program. In the case of acute URIs for which use of antibiotics is not recommended, no change attributable to the payment of incentives was observed in antibiotic prescription rates.

The implementation of financial incentives affected the number of antibiotic drugs prescribed for some of the diseases, but there was no consistency in the directionality of the changes. The number of antibiotics prescribed for URIs (adults) and infections in the urinary system (adults) rose immediately after the enforcement of the program, whereas it decreased for otitis media (adults) right after the implementation.

The length of antibiotic administration maintained its pre-implementation trend without showing any statistically significant changes due to the policy change.

For most of the diseases, antibiotic injection prescription rates showed no significant changes attributable to the financial incentive program, but otitis media (adults) was the only disease for which the program had an immediate impact, with the injection prescription rate falling by 1.3 percentage point.

High-priced antibiotic prescriptions had been already on the decrease for most of the diseases even before the program, and the financial incentive program affected monthly trends of high-priced drug prescriptions for LRIs (adults) and cystitis and other disorders of the urinary system (adults) in the downward direction.

This study analyzed changes in antibiotics prescription behavior for acute URIs in particular, for which use of antibiotics is not recommended, in relation to the implementation of the financial incentive program. The results do not show any statistically significant changes in antibiotics prescribed for the disease both before and after the program. The number of antibiotics prescribed and the percentage of injectable antibiotics prescribed already started to decrease before the program and maintained the trends even after that. In other words, as for acute URIs being monitored through the retrospective Drug Utilization Review System, it is confirmed that a more aggressive intervention strategy in the form of the financial incentive program has failed to exert impact on their antibiotic and injection prescription rates.

Among the diseases analyzed, however, otitis media (adults) was affected by the program, and its antibiotic prescription rate, injection prescription rate, and number of antibiotics prescribed decreased immediately or gradually. Since the analysis data of this study do not include detailed clinical data of the patients, we could not assess the reasonableness of antibiotic prescriptions one by one, but we can infer that the relatively bigger impact of financial incentives on antibiotic prescriptions for otitis media (adults) suggests that the disease had more room for reduction in antibiotic prescriptions. Otitis media (adults) was the only disease for which not only the pharmaceutical spending decreased immediately but also the time-series trend switched to the downward direction after the implementation. That is, among the diseases analyzed in this study, the disease affected the most by the financial incentive program is otitis media (adults), and it can be said that the decreasing consumption of antibiotics contributed to reduction in its overall pharmaceutical expenditures.

As for the across-the-board price cut, its effects were included only in the analysis of high-priced antibiotic prescription rates. Prescriptions of high-priced antibiotics rose for some of the diseases (LRIs (children), otitis media (children, adults)) right after the price cut. Part of the drug pricing system was amended at the same time as the drug prices were cut in April 2012. Prices of both the originator brand with an expired patent and its generic equivalents were adjusted to the same levels. In other words, the price difference between originator and generic drugs was either eliminated or narrowed. Consequently, the practical significance of "high-priced" drugs was greatly diminished. As a matter of fact, the NHIS stopped maintaining the high-cost drug list in the third quarter of 2012[2]. This means that the price differences between generic drugs and originator equivalents with expired patents have narrowed down to an extent that they no longer need to be

2) In our analysis of high-priced drug prescription rates in this study, we used the high-priced drug codes of the second quarter of 2012 for the third quarter of 2012 and afterwards.

tracked for management. The increases in high-priced drug prescriptions even after price differences were almost eliminated indicate that the prescriptions of drugs that were high-priced in the past increased.

3. Limitations of This Study

There are some limitations to this research. The first limitation to consider is the accuracy of variable measurements. In the case of injection prescription rates, one of the analysis indicators, it was defined as the percentage of injectable drugs prescribed even when there is an oral equivalent(s) with the same ingredients available. The assumption here is that injectable and oral medications are interchangeable. However, it is not always the case, and there are even some ingredients for which drugs in the oral dosage forms cannot replace injectable counterparts even if they have the same ingredients. This study could not factor in such details but proceeded to analyze injection prescription percentages and interpreted the meanings under the assumption that injectable and oral formulations with the same ingredients are replaceable with each other. This approach could have influenced the results of this study, which is based on the premise of replaceability, in the direction of increasing injection prescription percentages. But the influence worked in such a way that it increased injection rates over the entire period, and it is hard to say that, in relation to the implementation of the policies analyzed in this study, it could have affected the overall results any differently.

Next, with regard to high-priced drug prescriptions, high-priced drugs refer to those that are found on the insurance-covered drugs list and priced the highest among the equivalent drugs with the same ingredients, which are the same in definition as those tracked by the Health Insurance Review and Assessment Service. Until before the price cut in April 2012, the prices of generic drugs had been differentiated according to the sequence of listing. The prices of generics listed first through fifth in order were determined at the level of 85% of their originator equivalent. The generics listed afterwards was priced at 90% of the lowest-priced of the existing generics. After April 2012, generics are priced at the same level as their originator one year after the first generic is listed. When it comes to the drug prices listed before April 2012, however, it is necessary to examine whether the differences between the highest-priced and the second-highest or other products are significant enough to influence total pharmaceutical expenditures.

Second, this study considered the financial incentive program in October 2010 and the across-the-board price cut in April 2012 as the main policies and assumed that they should have influenced pharmaceutical prescription practices to change. However, it is possible that other policies introduced at similar times, such as the Dual Punishment System governing rebates in November 2010 and the full enforcement of Drug Utilization Review (DUR) in April 2011, affected drug prescribing behavior, but the impact of such other policies was not separately analyzed. Nonetheless, when it comes to dual punishments for rebates, it is hard to put it in one ward how cracking down on rebates affects pharmaceutical prescriptions. Since the reason for a pharmaceutical company to give a rebate is to boost prescriptions of its products, rebates may lead to growth in the overall volume of drugs prescribed, but the volume does not really increase if a drug of a certain company is chosen out of many alternative drugs. Also, under the circumstances in which rebate crackdown is getting strengthened, doctors tend to prefer originator brands to generics when prescribing drugs, but it is not always the case. Even if it does have the effect of increasing prescriptions of originator brands, it works in the opposite direction of the cost saving patterns expected of the financial incentive program. In short, it can be said that the effects of financial incentives will not be overestimated in this study on account of the dual punishment system.

Next, the purpose of DUR is not to change the volume of drugs prescribed but to prevent inappropriate prescriptions. Using a computerized system, the system checks prescriptions against contraindications of concomitant use, age contraindications or duplicated ingredients and inform prescribing doctors of the information. Doctors are not forced to change their prescriptions but entrusted to make decisions based on their professional judgment, and there is no incentive or disincentive associated with it. That is, it is unlikely for the DUR program to exert impact on pharmaceutical expenditures, the percentage of principal therapeutic agents prescribed, number of drugs prescribed, length of drug administration, percentage of injections prescribed and percentage of high-priced drugs prescribed as analyzed in this study. However, if duplicated ingredients are found in the course of prescription monitoring, prescription rates and the number of drugs prescribed may be affected. Yet the number of duplicated prescriptions discovered by the DUR is not big[3]; therefore it is believed that the impact on doctors' drug prescriptions will be very limited. Also, the dual punishment system and DUR are not one-time projects but have been strengthened and expanded over a period of years. Consequently, the impact of the policies are not expected to be very big. In addition to this, the method of research adopted in this study, the interrupted time series analysis, has the advantage of assessing policy effects by taking into

3) Between July 2009 and October 2009, the DUR information pop-up view was generated due to duplicated prescription for 1.29% of the prescriptions written by medical institutions (Lee EK. (2010). DUR Pilot Project Evaluations for Goyang City. *A Collection of Reports for the Sixth Autumn Symposium Hosted by the Korean Society of Pharmacoepidemiology and Risk Management*. November 10, 2010)

consideration the tendencies prior to the implementation of a policy. Therefore, the effects of the other policies on research results are considered to be very limited.

Third, it is assumed that over-time changes in result variable values are linear in the time series analysis model adopted in this study to analyze policy effects. However, the behavior of medical service providers following the implementation of a policy may react in a non-linear pattern. In this study, it turns out that pharmaceutical spending per prescription dropped after the execution of the financial incentive program, and the drug price cuts put monthly trends back on the upward path. If expenditures on prescription drugs had changed in a non-linear manner, it could probably have affected the trends of pharmaceutical spending observed after the price cuts. However, this is only a logical inference, and there is no proof that they actually reacted in a non-linear pattern.

4. Policy Implications and Tasks for the Future

This study assessed the effects of two policies enforced with the purpose of reducing pharmaceutical spending using time-series data. The two polices seek to achieve the common goal of containing pharmaceutical spending by reducing use of drugs and cutting drug prices, respectively. By analyzing changes in prescribing behavior due to the implementation of the respective policy, this study could evaluate the effects of both the policy that motivates doctors to cut down on prescription volumes through financial incentives as well as the other policy that marks down drug prices across the board.

According to the results, the financial incentive program that offers doctors with financial incentives to hold down pharmaceutical spending did have the effect of reducing the expenditures continuously afterwards, rather than having an immediate effect. This suggests that the financial incentives given directly to doctors in connection with reduction in drug volumes can produce the intended policy effect and may serve as an important basis for developing and pursuing policies to improve the quality of drug usage and manage pharmaceutical spending in the future.

Also, results of analyzing changes in antibiotic prescribing behavior for infectious diseases in relation to the implementation of the financial incentives show that overall volumes of antibiotics used decreased for some diseases, although the effects differed with the diseases, and that pharmaceutical expenses also decreased. This indicates that doctors will reduce prescriptions of antibiotics in which they see room for reduction when motivated to help reduce pharmaceutical spending, and it can serve as a good reference for other countries that want to develop programs to promote appropriate use of antibiotics.

Although prescription drug expenditures switched to a gradually decreasing trend after the implementation of the financial incentive program, some of the infectious diseases did not show a declining trend in antibiotic prescriptions. It is considered that reduction in the prescription volumes of other drugs could have affected the trend of pharmaceutical spending. Since all the prescribed drugs were not analyzed in this study, we could not identify changes in what part of the drug prescriptions were the main cause of the decreasing trend in pharmaceutical spending, and it needs to be found out through further research in the future.

In the meantime, price cuts immediately brought down pharmaceutical expenditures, but it is found that the market moved in the direction of gradually bringing them up again. This study did not investigate factors contributing to the switch of direction in pharmaceutical spending after the price cuts, and further research is required in this area.

This study analyzed policy effects based on the four-year data between 2009 and 2012 and produced meaningful results from a policy perspective. However, it is necessary to validate through more research in the future whether the policy effects observed in this study will continue over the longer term. It is also necessary to evaluate policy effects through further analysis focusing on diseases that were not covered by this study but have big implications from a health care perspective.

References

Adriaenssens N, Coenen S, Versporten A, Muller A, Minalu G, Faes C, Vankerckhoven V, Aerts M, Hens N, Molenberghs G, Goossens H; ESAC Project Group. (2011). European surveillance of antimicrobial consumption (ESAC): outpatient antibiotic use in Europe (1997-2009). *J Antimicrob Chemother*, 66 Suppl 6, vi3-12.

Ashiru-Oredope D, Sharland M, Charani E, McNulty C, Cooke J; ARHAI Antimicrobial Stewardship Group. (2012). Improving the quality of antibiotic prescribing in the NHS by developing a new Antimicrobial Stewardship Programme: Start Smart—Then Focus. *J Antimicrob Chemother*, 67 Suppl 1, i51-63.

Ashworth M, Armstrong D, Colwill S, Cohen A, Balazs J. (2000). Motivating general practitioners to change their prescribing: the incentive of working together. *Journal of Clinical Pharmacy and Therapeutics*, 25, pp.119-24.

Barnieh L, Clement F, Harris A, Blom M, Donaldson C, Klarenbach S, Husereau D, Lorenzetti D, Manns B. (2014). A systematic review of cost-sharing strategies used within publicly-funded drug plans in member countries of the Organisation for Economic Co-operation and Development. *PLOS One*, 9(3), e90434. pp.1-10.

Bergan T. (2001). Antibiotic usage in Nordic countries. *Int J Antimicrob Agents*, 18(3), pp.279-82.

Brick A, Gorecki PK, Nolan A. (2013). *Ireland: pharmaceutical prices, prescribing practices and usage of generics in a comparative context.* The Economic and Social Research Institute, Dublin.

Carone G, Schwierz C, Xavier A. (2012). *Cost-Containment Policies in Public Pharmaceutical Spending in the EU*. European Commission.

Godman B, Bishop I, Finlayson AE, Campbell S, Kwon HY, Bennie M. (2013). Reforms and initiatives in Scotland in recent years to encourage the prescribing of generic drugs, their influence and implications for other countries. Expert Rev. *Pharmacoecon, Outcomes Res*, 13, pp.469-82.

Godman B, Wettermark B, Bishop I, Burkhardt T, Furst J, Garuoliene K, Laius O, Martikainen JE, Sermet C, Teixeira I, Zara C, Gustafsson LL. (2012) European payer initiatives to reduce prescribing costs through use of generics. *Generics and Biosimilars Initiative Journal*, 1, pp.22-7.

Goossens H, Coenen S, Costers M, De Corte S, De Sutter A, Gordts B, Laurier L, Struelens M. (2008). Achievements of the Belgian Antibiotic Policy Coordination Committee (BAPCOC). *Euro Surveill*, 13(46), pii: 19036.

Harris CM & Scrivener G. (1996). Fundholders' prescribing cost: the first five years. *BMJ*, 313, pp.1531-4.

Health Insurance Review and Assessment Service. (2006). *Results of the retrospective Drug Utilization Review for the Third Quarter of 2005*. (in Korea)

Health Insurance Review and Assessment Service. (2013a). *Results of the retrospective Drug Utilization Review for the First Half of 2012*. (in Korea)

Health Insurance Review and Assessment Service. (2013b). *Results of the retrospective Drug Utilization Review for the Second Half of 2012*. (in Korea)

Hillman AL, Pauly MV, Escarce JJ, Ripley K, Gaynor M, Clouse J, Ross R. (1999). Financial incentives and drug spending in managed care. *Health Affairs*, 18, pp.189-200.

Jang SM, Park CM, Bae GR, Lee HJ, Kim HS. (2010). *An Analysis of Cost Drivers for NHIS Pharmaceutical Expenditures*. Health Insurance Review and Assessment Service. (in Korea)

Kuyvenhoven MM1, van Balen FA, Verheij TJ. (2003). Outpatient antibiotic prescriptions from 1992 to 2001 in the Netherlands. *J Antimicrob Chemother*, 52(4), pp.675-8.

Mangione-Smith, R, Wong L, Elliott MN, McDonald L, Roski J. (2005). Measuring the quality of antibiotic prescribing for upper respiratory infections and bronchitis in 5 US health plans. *Arch Pediatr Adolesc Med*, 159(8), pp.751-7.

Ministry of Health and Welfare. (2012). 2011 *White Paper on Health and Welfare*. (in Korea)

Morgan SG, Thomson PA, Daw JR, Friesen MK, Dijkstra A. (2012). *The public provision of pharmaceuticals: a synthesis of policies in ten developed countries*. Pharmaceutical Policy Research Collaboration.

National Health Insurance Service. (2013). *Practical Health and Welfare Plan II—A Plan for Improving the Supply System of Health and Medical Services*. (in Korea)

Nguyen KV, Thi Do NT, Chandna A, Nguyen TV, Pham CV, Doan PM, Nguyen AQ, Thi Nguyen CK, Larsson M, Escalante S, Olowokure B, Laxminarayan R, Gelband H, Horby P, Thi Ngo HB, Hoang MT, Farrar J, Hien TT, Wertheim HF. (2013). Antibiotic use and resistance in emerging economies: a situation analysis for Viet Nam. *BMC Public Health*, 13, 1158.

NPS. (2006). *Indicators of Quality Prescribing in Australian General Practice*.

OECD. (2012). *OECD Health Data*.

Park S, Chang YS, Chae SM, Park EJ, Lee EK, Lee IH. (2012). *An In-Depth Analysis of Pharmaceutical Consumption and Sales Statistics for 2011*. Ministry of Health and Welfare/Korea Institute for Health and Social Affairs. (in Korea)

Rafferty T, Wilson-Davis K, McGavock H. (1997). How has fundholding in Northern Ireland affected prescribing patterns? A longitudinal study. *BMJ*, 315, pp.166-70.

Sabuncu E, David J, Bernede-Bauduin C, Pepin S, Leroy M, Boelle PY, Watier L, Guillemot D. (2009). Significant reduction of antibiotic use in the community after a nationwide campaign in France, 2002-2007. *PLoS Med*, 6(6), e1000084.

Sood N, de Vries H, Gutierrez I, Lakdawalla DN, Goldman DP. (2009). The effect of regulation on pharmaceutical revenues: experience in nineteen countries. *Health Affairs*, 28, w125-37.

Tele P & Groot W. (2009). Cost containment measures for pharmaceuticals expenditure in the EU countries: a comparative analysis. *The Open Health Services and Policy Journal*, 2, pp. 71-83.

Wagner AK, Soumerai SB, Zhang F, Ross-Degnan D. (2002). Segmented regression analysis of interrupted time series studies in medication use research. *J Clin Pharm & Therapeutics*, 27, pp.299-309.

Walley T, Murphy M, Fodd M, Johnston Z, Quirke T. (2000). Effects of monetary incentive on primary care prescribing in Ireland: changes in prescribing patterns in one health board 1990-1995.

Pharmacoepidemiology and Drug Safety, 9, pp.591-8.

Walley T & Mossialos E. (2004). Financial incentives and prescribing. In: Mossialos E, Mrazek M, Walley T.(Eds.). *Regulating Pharmaceuticals in Europe: Striving for Efficiency, Equity and Quality*(pp.114-29), Open University Press.

Wilson RP, Buchan I, Walley T. (1995). Alterations in prescribing by general practitioner fundholders: an observational study. *BMJ*, 311, pp.1347-50.

Wolff J. (2011). *Pharmaceutical cost-control*. London's Global University.

Zoorob R, Sidani MA, Fremont RD, Kihlberg C. (2012). Antibiotic use in acute upper respiratory tract infections. *Am. Fam. Physician*, 86(9), pp.817-22.