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ORIGINAL RESEARCH

Impact of Cardiac Rehabilitation Health Insurance Coverage on Cardiac Rehabilitation Use in Korea Using an Interrupted Time Series

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BACKGROUND: Since 2017, the cardiac rehabilitation (CR) program in Korea has been included in the coverage provided by the National Health Insurance to alleviate financial burden. Our study aimed to identify changes in the CR program use according to the implementation of CR coverage.

METHODS AND RESULTS: We obtained data from the electronic medical records of a tertiary hospital in Seoul, Korea from January 2014 to February 2020. Data from 2988 patients with acute coronary syndrome who underwent percutaneous coronary intervention were included. To examine the CR use trend among patients undergoing percutaneous coronary intervention, the electronic medical records data of the patients were aggregated quarterly, resulting in a maximum of 24 repeated measures for each patient. Segmented regression is often used to estimate the effects of interventions in an interrupted time series. Policy implementation led to a prompt increase in the probability of CR use (odds ratio [OR], 3.99 [95% CI, 2.89–5.51]). After the implementation of CR coverage, no significant change in CR use (OR, 0.97 [95% CI, 0.92–1.01]) was observed. After percutaneous coronary intervention, more patients opted for CR, especially those receiving education compared with exercise (education: OR, 87.44 [95% CI, 36.79–207.83] versus exercise: OR, 1.99 [95% CI, 1.43–2.76]).

CONCLUSIONS: The implementation of CR coverage resulted in a rapid increase in the probability of CR use. Use of the educational program was higher than that of the exercise program. Given the persistently low use of CR, it is imperative to stimulate its adoption by increasing its availability.

Key Words: cardiac rehabilitation ■ cardiovascular diseases ■ myocardial infarction ■ stroke

Heart disease is a major cause of premature mortality and an important cause of disability globally.[1] The World Heart Federation reported that the global economic burden of cardiovascular disease was estimated to be approximately US $863 billion in 2010 and is projected to exceed US $1 trillion by 2030.[2] In Korea, heart disease is the second leading cause of mortality. The number of cases of heart disease rose from 54 247 in 2009 to 69 033 in 2022.[3] Acute coronary syndrome (ACS) presents as a sudden onset of symptoms; however, it is important to recognize that it stems from the gradual progression of chronic systemic vascular disease, namely atherosclerosis, over an extended period. Additionally, even after receiving suitable acute-phase treatment, patients remain in an enduring vascular condition, emphasizing the

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CLINICAL PERSPECTIVE

What Is New?

- This study demonstrated that since the introduction of health insurance coverage for cardiac rehabilitation, there has been an increase in participation among patients after percutaneous coronary intervention in South Korea.

What Are the Clinical Implications?

- Using National Health Insurance to reduce out-of-pocket expenses for cardiac rehabilitation has proven to be effective in increasing participation in cardiac rehabilitation.
- Additional research is required to assess the effect National Health Insurance coverage has on completion of cardiac rehabilitation and to evaluate whether the effects of health insurance coverage on cardiac rehabilitation participation apply universally across all regions.

Nonstandard Abbreviation and Acronym

CR	cardiac rehabilitation

necessity for lifelong treatment and ongoing management upon discharge.[4]

Both the 2010 Cardiac Rehabilitation Performance Measures and the 2016 European Society of Cardiology Cardiovascular Disease Prevention Guidelines recommend cardiac rehabilitation (CR) as an essential component of the ongoing management of ACS.[5,6] Prior studies have presented the benefits associated with CR, such as reduced mortality rates, readmission, and risk of myocardial infarction.[7–10] Presently, CR is a comprehensive program aimed at enhancing various aspects of patient well-being, including physical, psychological, social, emotional, and vocational status.[11]

Despite the well-documented benefits of CR and the official endorsement of CR referrals by guidelines, CR program use remains significantly low. Globally, only 38.8% of countries have implemented CR programs.[12–15] Specifically, 68.0% of high-income countries and 23% of low-middle-income countries offer CR services to individuals with cardiovascular disease.[15–17]

In Korea, the participation rate in CR programs among cardiac patients is extremely low, ranging from 0.0% to 6.4%, even in hospitals that actively offer CR services (14%–35%).[18,19] There is still a strong focus on acute-phase interventions in Korea, with limited knowledge and understanding of CR programs.[20] Since 2005, the Korean government has implemented a policy aimed at enhancing health insurance coverage to alleviate the financial strain caused by major illnesses such as cancer, heart disease, and cerebrovascular disease. This initiative aims to reduce out-of-pocket expenses and convert benefits into previously unknown items. As part of this effort, since February 2017, the CR program in Korea has been included in the coverage provided by the National Health Insurance. After National Health Insurance coverage, the out-of-pocket cost for CR exercise at a general hospital is approximately $18, and the out-of-pocket cost for CR education is about $9. In other countries, there were several studies on the participation and related costs of CR. A retrospective cohort study in the United States showed that as cost sharing increased, the participation rate in CR decreased.[21] Moreover, randomized controlled trials demonstrated that providing financial incentives for low-income groups significantly increased the likelihood of participation and completion of CR.[22]

Few studies have examined the impact of reducing out-of-pocket costs on CR program use. Our study aimed to identify changes in the CR program use trend according to the implementation of CR program coverage.

METHODS

The data in this study were extracted from the electronic medical records from January 2014 to February 2020 of a tertiary hospital located in Seoul, Korea. Relevant clinical information of eligible patients, including demographics, medical history, vital signs, laboratory results, ACS diagnosis, education level, surgery type, and surgical procedure, was available for analysis. This study was approved by the institutional review board of the Yonsei University Health System (4-2022-0452). The ethics committee waived the need for informed consent because the Korean Vital Statistics database contains public, anonymized, and unidentified patient information. The researchers complied with the principles outlined in the Declaration of Helsinki and adhered to the protocol for the research project, prioritizing ethical and safe practices.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Design and Participants

We conducted an ecological study to assess the effects of CR coverage on the quarterly probability of cardiac use. Starting in February 2017, CR program coverage was included with the National Health Insurance

(Table S1). We used time-series data collected from patients diagnosed with ACS who underwent their first percutaneous coronary intervention (PCI) and coronary artery bypass grafting. To ensure accuracy, certain exclusion criteria were established, such as individuals who underwent PCI procedures before 2014 and those diagnosed with strokes before 2014 for ensuring a consistent and comparable study population. Furthermore, individuals covered by the medical aid program, which offers health care benefits to economically disadvantaged families, were excluded due to the distinct health care systems in South Korea. Additionally, individuals who passed away within 30 days after their discharge were not considered in the analysis. Finally, 2988 patients were included in the study (Figure 1).

In this study, we used an interrupted time-series approach to analyze the quarterly probability of patients using CR based on their medical record data (referred to as Model 1). We estimated the baseline trend ($\beta 1$) before the probability of using CR, whereas $\beta 2$ depicts the difference in baseline slope between the segments before and after the policy was implemented. $\beta 3$ represents the change in trend, which is the difference in slope between the segment following the policy and the segment preceding it. $\beta 1+\beta 3$ represents the postpolicy probability of using CR. In summary, this approach allowed us to closely examine and quantify the impact of CR use with implementation of CR reimbursement.

$$\text{Model 1: } Y_t = \beta 0 + \beta 1 \times \text{Time}_t + \beta 2 \times \text{policy}_t + \beta 3 \times \text{time after policy}_t + \beta 4 \times \text{covariates}_t + e_t$$

Cardiac Rehabilitation

We assessed CR use, which was defined as engagement in the CR program within 30 days of discharge post-PCI. The CR program encompassed 3 core components: education, exercise, and evaluation, and each patient was engaged in distinct elements as indicated by fee codes. Starting from February 2017, health insurance has provided coverage for all 3 CR program types, resulting in a significant reduction in patients' out-of-pocket expenses. Patients can participate in CR programs of different types based on their physician's recommendation or their own choice after a PCI procedure. Nevertheless, it is worth noting that during our study period, there were no patients who took part in the evaluation component of the CR program. CR use

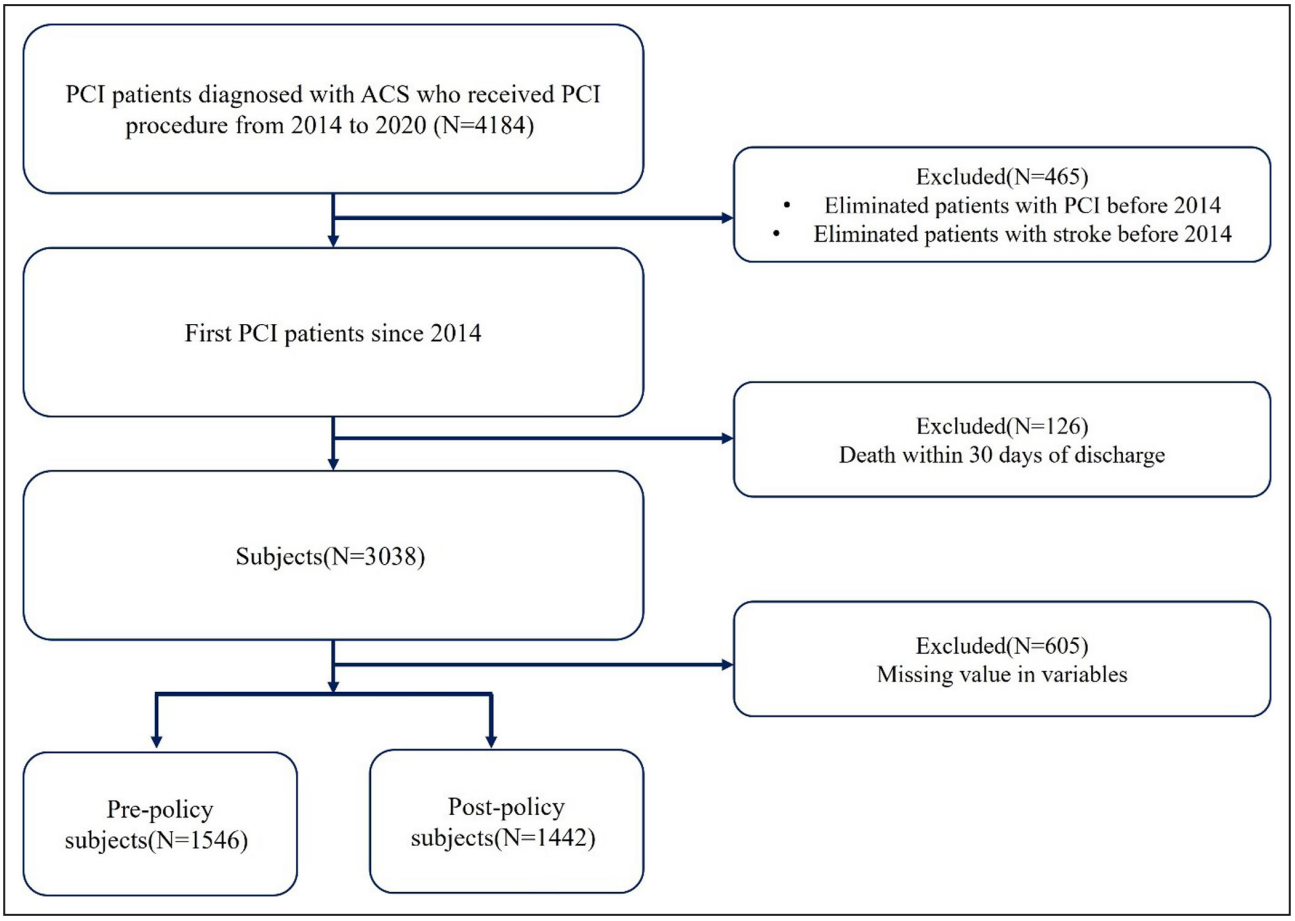

Figure 1. Flowchart of the study.
ACS indicates acute coronary syndrome; and PCI, percutaneous coronary intervention.

was defined by a patient's involvement in ≥1 of the CR program elements (education and exercise) within the initial 30 days following their PCI discharge.

Variables

To address potential factors that could influence health care use, we used the Anderson model for confounding control. In accordance with this model, we selected covariates (Figure S1). We controlled for predisposing factors, which encompassed sociodemographic and socioeconomic elements, as well as enabling factors that encompassed the ability to cover medical expenses. Additionally, we considered need factors, which included health condition and clinical indicators serving as proxy measures for assessing the severity of the patient's health status.[23,24] Sociodemographic variables included sex (men or women), age groups (<60, 60–69, and ≥70 years), and education level (elementary or middle school, high school). Socioeconomic factors encompassed the ability to cover medical expenses (yes or no). Health-related aspects encompassed smoking status (current, former, nonsmoker), body mass index (<25, ≥25), regular exercise (yes or no), and medical history (hypertension, dyslipidemia, cancer, chronic kidney disease).

We also considered 5 clinical factors. When patients were initially diagnosed with their first ACS, the diagnosis was categorized into unstable angina (I20.0, I24.0), identified by *International Classification of Diseases, Tenth Revision* (*ICD-10*) codes, and distinguished from myocardial infarction (I21, I22, I23, I25.2, I25.5). Patients were further categorized based on their use of stents during PCI procedures, with stent operators defined as those who used stents at least once and ballooning operators as those exclusively performing ballooning procedures. Additionally, a few cases involving percutaneous thrombectomy, embolectomy, and coronary artery bypass grafting were included in the ballooning procedure category, with the corresponding *ICD-10* codes provided in Table S2. Furthermore, we incorporated information about the number of vascular stenoses (1, 2, or ≥3), the number of stents used (0, 1, ≥2), and the target vessel of the PCI procedure (left main or left anterior descending artery, others) according to the surgical notes.

Statistical Analysis

The χ^2 test was used to identify differences in CR use according to the covariates. Also, we explored the fitted line to demonstrate the covariate adjustments incorporated in our model using an effect plot (Figure S2). To examine the trend in CR use among patients undergoing PCI, the emergency medical record data of patients were aggregated quarterly, resulting in a maximum of 24 repeated measures for each patient. Segmented regression is often used to estimate the effects of interventions in an interrupted time series.[25] The analysis used a generalized linear model with a binary distribution and logit link function specifically designed for the interrupted time-series design. A generalized estimating equation and autoregressive covariance were used. All analyses were conducted using SAS software version 9.3 (SAS Institute, Cary, NC).

RESULTS

Table 1 presents the general characteristics of the participants. A total of 2988 participants were included in the analysis. Among the patients who underwent PCI, 339 (11.3%) had incident myocardial infarction within 1 year of discharge, and 31 (1%) developed a stroke. A total of 1156 (38.7%) participated in the CR program.

Figure 2 and Table S3 present the CR use probability trend per quarter using segmented regression analysis. The probability of CR use in preimplementation policy showed an upward trend (exponentiated regression coefficient, 1.02 [95% CI, 0.99–1.06]). Implementation of the policy led to an immediate effect, increasing in the probability of CR use (exponentiated regression coefficient, 3.99 [95% CI, 2.89–5.51]). Trend change of the probability of CR use was decreasing but not significantly (exponentiated regression coefficient, 0.97 [95% CI, 0.92–1.01]). Additionally, the post-trend of the probability of CR use was decreasing but not significantly (exponentiated regression coefficient, 0.98 [95% CI, 0.95–1.01]).

Table 2 shows the CR use probability trend by using segmented regression analysis stratified by each type of CR. Fourteen patients (0.9%) participated in the education program before the implementation of the policy, but 755 patients (52.4%) participated in CR after the implementation of the policy. Implementation of the policy led to an immediate effect increasing in the probability of participation in CR education (exponentiated regression coefficient, 87.44 [95% CI, 36.79–207.83]). Before the implementation of the policy, 23.2% of patients used exercise programs after PCI procedures, but 34.5% of patients used exercise programs after implementation of the policy. This trend increased marginally before the implementation (exponentiated regression coefficient, 1.02 [95% CI, 0.99–1.06]). The policy's implementation resulted in an immediate surge in the likelihood of patients participating in CR exercise (exponentiated regression coefficient, 1.99 [95% CI, 1.43–2.76]). Moreover, the change of trend in probability of using CR decreased per quarter (exponentiated regression coefficient, 0.95 [95% CI, 0.90–0.99]).

DISCUSSION

In this study, we investigated the effect of CR coverage on CR use among patients undergoing PCI in Korea.

Table 1. General Characteristics of the Study Population

Variables	National Health Insurance coverage of cardiac rehabilitation						*P* value
	Total		Prepolicy		Postpolicy		
	N	%	N	%	N	%	
Total	2988	100.0	1546	51.7	1442	48.3	
Sex							0.0823
Men	2243	75.1	1140	50.8	1103	49.2	
Women	745	24.9	406	54.5	339	45.5	
Age, y							0.9084
50–59	1060	35.5	552	52.1	508	47.9	
60–69	917	30.7	469	51.1	448	48.9	
≥70	1011	33.8	525	51.9	486	48.1	
Guardian status							0.0226
Yes	2900	97.1	1511	52.1	1389	47.9	
No	88	2.9	35	39.8	53	60.2	
Educational level							0.1353
Elementary or middle school	821	27.5	443	54.0	378	46.0	
High school, college or above	2167	72.5	1103	50.9	1064	49.1	
Difficulty paying medical bill							0.0585
Yes	152	5.1	90	59.2	62	40.8	
No	2836	94.9	1456	51.3	1380	48.7	
Smoking status							0.4504
Current smoker	732	24.5	368	50.3	364	49.7	
Ex-smoker	795	26.6	425	53.5	370	46.5	
Nonsmoker	1461	48.9	753	51.5	708	48.5	
Drinking status							0.5156
Current drinker	1171	39.2	592	50.6	579	49.4	
Ex-drinker	405	13.6	217	53.6	188	46.4	
Nondrinker	1412	47.3	737	52.2	675	47.8	
BMI, kg/m^2							0.1291
<25	1671	55.9	844	50.5	827	49.5	
≥25	1317	44.1	702	53.3	615	46.7	
Regular exercise							0.511
Yes	500	16.7	252	50.4	248	49.6	
No	2488	83.3	1294	52.0	1194	48.0	
Risk factors							
Hypertension							0.0293
No	622	20.8	346	55.6	276	44.4	
Yes	2366	79.2	1200	50.7	1166	49.3	
Diabetes							0.0002
No	1619	54.2	787	48.6	832	51.4	
Yes	1369	45.8	759	55.4	610	44.6	
Dyslipidemia							<0.0001
No	513	17.2	220	42.9	293	57.1	
Yes	2475	82.8	1326	53.6	1149	46.4	
Cancer							0.0408
No	2614	87.5	1334	51.0	1280	49.0	
Yes	374	12.5	212	56.7	162	43.3	

(*Continued*)

Table 1. Continued

Variables	National Health Insurance coverage of cardiac rehabilitation						*P* value
	Total		Prepolicy		Postpolicy		
	N	%	N	%	N	%	
Chronic kidney disease							0.5461
No	1685	56.4	880	52.2	805	47.8	
Yes	1303	43.6	666	51.1	637	48.9	
Cardiac diagnosis							<0.0001
UA	1625	54.4	925	56.9	700	43.1	
MI	1363	45.6	621	45.6	742	54.4	
Type of procedure							0.0015
PCI (stent)	2875	96.2	1471	51.2	1404	48.8	
PTCA (balloon)	113	3.8	75	66.4	38	33.6	
Target vessel							0.2443
LM and LAD	1735	58.1	882	50.8	853	49.2	
Others	1253	41.9	664	53.0	589	47.0	
No. of stenosis vessels							0.5386
1	1258	42.1	636	50.6	622	49.4	
2	946	31.7	499	52.7	447	47.3	
≥3	784	26.2	411	52.4	373	47.6	
No. of stents							0.0002
None	108	3.6	73	67.6	35	32.4	
1	2010	67.3	1057	52.6	953	47.4	
≥2	870	29.1	416	47.8	454	52.2	

BMI indicates body mass index; LAD, left anterior descending artery; LM, left main artery; MI, myocardial infarction; PCI, percutaneous coronary intervention; PTCA, percutaneous transluminal coronary angioplasty; and UA, unstable angina.

Our results indicated that the likelihood of CR use after PCI increased by 2% biannually before policy implementation. Although the implementation of CR coverage led to a prompt increase in the likelihood of CR use, it did not continuously increase after implementation. Therefore, CR coverage resulted in an immediate increase in the use of CR programs among patients undergoing PCI.

In prior studies, it has been well documented that certain factors are associated with lower CR uptake, such as female sex, older age, ethnocultural minorities, smoking, long distance to the nearest provider of CR, and comorbidity.[26–30] CR appears to reach a healthier population that is in less need of the limited CR spots available. Insurance coverage is a strategy to address underuse-related factors. Patients with insufficient insurance coverage to compensate for CR services are less inclined to receive CR programs.[31] Also, a Cochrane review recommended CR reimbursement as an effective intervention to increase CR use.[32,33]

An online survey encompassing all members of the International Council of Cardiovascular Prevention and Rehabilitation, comprising 24 countries, investigated the entities that provide partial reimbursement for CR services in their respective countries. The responses indicated that reimbursement for CR services primarily originated from the government, followed by individual contributions and private insurance companies.[33] In the case of Korea, where the entire population is covered by the National Health Insurance, the target population that receives compensation for CR services is significantly larger compared with countries relying on private insurance. As a result, our findings may reflect a substantial increase in CR use owing to its broad application and reimbursement within a wide population. Expanding the scope of CR reimbursement in various countries could potentially encourage patient participation in CR. Therefore, supporting CR reimbursement is important.[34]

The results of our study showed an increase in CR program use among patients after the PCI procedure, especially those who participated in the education program compared with the exercise program. The likelihood of an educational program increased highly because of the small number of patients with participation in the educational program before implementing the CR coverage policy. In addition, the absolute number of patients who implemented the educational program was higher than that of patients who had implemented the exercise programs. This is similar to

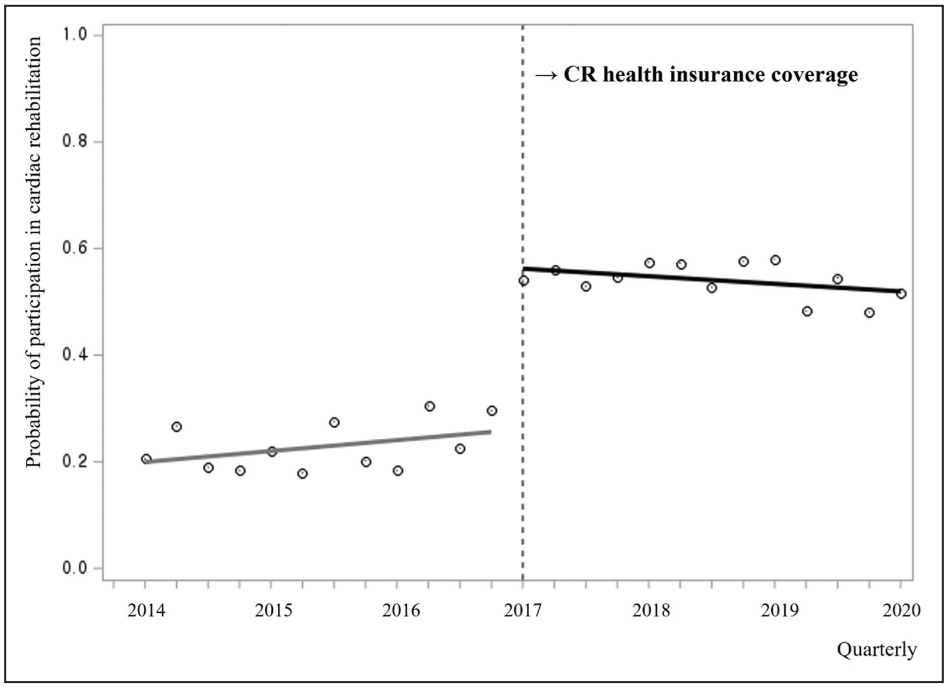

Figure 2. Insurance coverage of CR in the Republic of Korea: interrupted time-series analysis of participation in CR before and after the policy.
The dots are the quarterly probability of participation in CR (observed). The vertical gray dotted line shows the beginning of the CR National Health Insurance coverage (February 2017). The solid gray line is the pretrend adjusted for covariates (exponentiated regression coefficient 1.02). At the vertical gray dotted line, an immediate effect is observed in the probability of CR use (exponentiated regression coefficient 3.99 [95% CI, 2.89–5.51]). The solid black line is the fitted trend line post-CR National Health Insurance coverage (exponentiated regression coefficient 0.98 [95% CI, 0.95–1.01]). CR indicates cardiac rehabilitation.

the results of previous studies involving regional cardiocerebrovascular centers in Korea, which have a high rate of patient education. However, the participation rate in CR exercise training during hospitalization was insufficient, and there were lower enrollment and adherence rates in the CR program after discharge.[35]

Despite the formal introduction of CR coverage, underuse of CR persists. This underuse can be ascribed to a multitude of factors spanning patient characteristics, referring practitioners, program specifications, and health care systems.[32] In the context of South Korea specifically, the delivery of CR to patients is impeded by inadequate infrastructure resources.[18] For those health care establishments offering CR, specialists pinpointed patient referrals, transportation, and cost as major obstacles. Conversely, institutions lacking CR face multifaceted challenges, particularly those pertaining to equipment, physical space, human resources, and fiscal allocation.[36] The establishment of such infrastructural resources extends beyond mere equipment provision and necessitates substantial human resources and budgetary considerations, both of which present significant challenges. Various models and methods are being proposed to overcome such facility and resource limitations and increase participation in CR. One study discussed a home-based CR delivery model as applicable to countries with limited

Table 2. Results of Interrupted Time-Series Analysis of Insurance Coverage on Cardiac Rehabilitation Participation

	Participation in cardiac rehabilitation									
	Prepolicy		Postpolicy		Pretrend		Postlevel change		Posttrend change	
Variables	N	%	N	%	Coefficient (β1)	95% CI	Coefficient (β2)	95% CI	Coefficient (β3)	95% CI
Type of cardiac rehabilitation										
Education	14	0.9	755	52.4	1.09	(0.95–1.26)	87.44	(36.79–207.83)	0.91	(0.79–1.05)
Exercise	358	23.2	498	34.5	1.02	(0.99–1.06)	1.99	(1.43–2.76)	0.95	(0.90–0.99)

All results are adjusted for covariates, and presented as exponentiated coefficient.

facilities such as those with middle-income status.[37] Another study proposed a delivery system for virtual CR as a supplement to facility-based rehabilitation, aiming to overcome geographic or access barriers for patients.[38] Various societies and organizations offer a range of programs to support training for CR professionals.[39–41] Using these available resources and various model, the government should consider strategies to enhance the infrastructure for CR.

This study has several limitations. First, this was a retrospective study performed in a single tertiary university hospital that lacked external validity. However, our study has the strengths of including a patient group with a history of ACS, which is a high-risk group for major adverse cardiovascular events, detailed long-term follow-up surveillance data, and an analysis of detailed PCI procedures and the status of ACS, which are related to the incidence of major adverse cardiovascular events. This strengthened the accuracy of our findings. However, further studies with larger sample sizes and national representative data are required to validate our findings. Second, we were unable to account for all the additional unofficial benefits and policies extended to individuals engaged in CR during the same period. Nonetheless, it is important to note that during that period, CR coverage represented the most extensive and officially endorsed policy. Third, our study focused on investigating the probability of participation in CR among patients who underwent PCI. However, eligible conditions for patients related to CR health insurance coverage also apply to other cardiac conditions such as heart failure and atrial fibrillation. Therefore, additional research on this aspect will be needed.

CONCLUSIONS

We investigated the association between CR coverage and use in patients who underwent PCI. The implementation of CR coverage resulted in a rapid increase in the probability of CR use. Use of the CR educational program was higher than that of the exercise program. Given the persistently low use of CR, it is imperative to stimulate its adoption by increasing its availability.

ARTICLE INFORMATION

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Disclosures

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Supplemental Material

Tables S1–S3
Figures S1–S2

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