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# The use and the cost of outpatient diagnostic procedures for cardiovascular diseases in Isfahan province: A utilization study

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**Abstract:**

**BACKGROUND:** Cardiovascular diseases (CVDs) are among the most important causes of premature death, disability, disease burden, and increasing the cost of healthcare worldwide. Having an overview of service utilization can help policymakers to plan more effective use of those services and to cut costs. Thus, this study aims to determine the amount of use as well as the cost of various outpatient diagnostic procedures for CVDs in Isfahan province of Iran from 2011 to 2017.

**MATERIALS AND METHODS:** This descriptive study used insurance claim data (time period: 2011–2017) from Health Insurance Organization in Isfahan province to determine the amount of use and the cost of various outpatient diagnostic procedures for CVDs. Afterward, based on these data, the use and the cost of various outpatient diagnostic procedures for CVDs were estimated for the total population of Isfahan province. The list of outpatient diagnostic procedures for CVDs was carefully chosen according to experts' opinions.

**RESULTS:** The use and the cost of outpatient diagnostic procedures for CVDs have drastically increased in the study period (2011–2017). Since 2011, the number of procedures and their related costs have increased 6.6 and 30.76 times (11.74 times, adjusted with PPP conversion factor), respectively. Per capita use (per thousand people) was 18.75 in 2011, reaching 116.51 in 2017. Per capita cost (per thousand people) was 1,887,660 IRR (355 PPP\$) in 2011, reaching 54,660,365 IRR (3920 PPP\$) in 2017. The highest cost and use were related to echocardiography and electrocardiography, respectively. A notable increase has been observed in the share of radionuclide myocardial perfusion scan and analysis of pacemakers and ICDs of the total cost.

**CONCLUSIONS:** The use of outpatient diagnostic procedures for CVDs has drastically increased during the studied period. Consequently, the cost borne by the health system and the patients have notably increased. This may be because of the increase in the incidence and prevalence of CVDs during the study period. Greater access to related health services can be mentioned as another reason for this increase. Further research is needed to explain all potential reasons and their importance, which can provoke a suitable health policy reaction.

**Keywords:**

Cardiovascular diseases, cost, outpatient, utilization study

**Key messages**

The use and the cost of outpatient diagnostic procedures for CVDs are increasing drastically. Since 2011, the use of and its

related costs have increased about 7 and 31 times (about 12 times adjusted with PPP conversion factor), respectively. Besides CVD control programs, appropriate cost containment policies should be adopted.

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## Introduction

Cardiovascular diseases (CVDs) are among the most important causes of premature death, disability, disease burden, and increased cost of healthcare worldwide. In the last three decades, the global prevalence of CVDs has increased by 93% (271 million in 1990 to 523 million in 2019). Deaths associated with CVDs have also increased by 1.5 times, from 12.1 million in 1990 to 18.6 in 2019. CVDs were also the cause of 6.2 million deaths occurring between the ages of 30 and 70 years in 2019.<sup>[1]</sup> According to the 2018 reports of the World Health Organization, the total number of NCD-related deaths in Iran in 2016 amount to 304,400 persons. CVD-related deaths in Iran amount to 130,892 persons. Moreover, the probability of premature mortality from NCDs was 15%.<sup>[2]</sup> In 2011, 44% of Isfahan province's mortality resulted from CVDs.<sup>[3]</sup> Given the increasing trend of CVD prevalence, it is no wonder that screening tests and diagnostic tools for evaluating CVDs have also increased. The electrocardiogram (ECG) is the most used screening test and the most important early diagnostic tool for evaluating patients with chest pain, in addition to diagnosing suspected cases of acute coronary syndrome and heart attacks. The test has a relatively low cost, high availability, and noninvasive nature.<sup>[4]</sup> Also, echocardiography is the diagnostic and noninvasive method that provides information related to heart function. It is the most frequently used cardiovascular diagnostic test after electrocardiography and chest X-rays. Therefore, it is advantageous in the diagnosis and triage of acute chest pain and shortness of breath.<sup>[5]</sup> The exercise ECG stress test is also considered a noninvasive and accessible tool and one of the most critical methods of evaluating heart coronary artery diseases. Changes in ECG in combination with other clinical parameters derived from the above process eliminate low-risk patients with high precision, helping the appropriate and effective redistribution of scarce resources.<sup>[6]</sup> Accordingly, outpatient medical procedures for diagnosing CVDs are often noninvasive and useful in the early detection of such diseases.

According to Secretariat (2010), in recent decades, the use of noninvasive cardiac tests has rapidly increased in Ontario and other locations. However, the increase is also attributed to demographic changes and the prevalence of heart diseases. In addition, considerable uncertainty exists in the appropriate choice, sequence, and frequency of cardiac imaging tests in various medical situations. In this respect, there are persistent and increasing concerns regarding duplicated tests.<sup>[7]</sup> Lucas *et al.* (2006),<sup>[8]</sup> in a study on Medicare patients from 1993 to 2001, showed that a significant increase had occurred in diagnosis and treatment of coronary artery disease in the period among the mentioned demographic. They further showed that

there had also been a significant increase in the use of cardiac services in the same period, such that the relative rate for most services had doubled. However, the increase was not similar in all methods. According to the mentioned study's analysis, it is unlikely that the increase can be attributed to a rise in the prevalence of underlying diseases because the rate of hospitalization for acute myocardial infarction in the same population has not increased.

Hertz *et al.* (2019)<sup>[9]</sup> showed that from 2008 to 2014 in Brazil, 4,653,884 cardiac diagnostic procedures had been performed, with an estimated cost of 271 million dollars. These procedures took place in 1672 healthcare facilities. The most frequently used test for this purpose was stress ECG (3,015,993 cases). Pearlman *et al.* (2007)<sup>[10]</sup> reported that between 1999 and 2004, echocardiography services rapidly increased, with an annual actual growth rate of 7.7%. The increasing use of echocardiography in clinics has caused an increase in the costs involved. Furthermore, changes in the prevalence of heart diseases have contributed to changes in the use of the mentioned method in different geographical locations.

Virnig *et al.* (2014)<sup>[11]</sup> found that echocardiography was one of the most frequently used methods among the Medicare-enrolled population. Each year, approximately 20% of people enrolled in the fee-for-service system had received at least one cardiac echocardiography. The use of echocardiography in the United States rapidly increased between the 1990s and the early 2000s, such that the method was used at a higher rate than non-cardiac imaging services. Although using echocardiography was expected to increase further due to the growth in the aging population, the method continued its accelerated growth in use, albeit not as high as predicted. By 2010, echocardiography services comprised 11% of total Medicare costs for imaging services, costing approximately 1.2 billion dollars. According to available data, the recent changes in the payment policy have decreased the total permissible costs but have not decreased the percentage of people receiving such services and the average number of echocardiography services per person. In a retrospective cohort study, Kini *et al.* (2019)<sup>[12]</sup> investigated the trend of using cardiovascular diagnosis tests in the fee-for-service payment system from 1999 to 2016. They found that the overall number of such tests increased from 1999 to 2008 but then continuously declined until 2016. According to the mentioned study, the number of diagnostic tests increased from 275 tests per thousand people in 2000 to 359 tests in 2008 but decreased to 316 tests per thousand people by 2016. The number of echocardiography procedures also increased from 141 in 1999 to 227 in 2009 but similarly declined to 210 cases in 2016. According to their findings,

the number of low-value diagnostic cardiovascular testing has decreased dramatically, while the number of high-value diagnostic cardiovascular testing has increased. Several studies have revealed that CVDs have appropriated a significant economic costs and these costs are increasing.<sup>[1,13-18]</sup>

As mentioned above, the substantial part of the incurred cost is because of diagnostic procedures for CVDs while unnecessary use of those procedures is not uncommon. Having an overview of service utilization can help public health policymakers to plan more effective use of those services and to cut costs. Such information is a prerequisite to proper analysis of the current situation and the foundation of future policymaking. Given the limitations on documentation of such information at the national level and Isfahan province, the present study aimed to determine the use and cost of various outpatient diagnostic procedures for CVDs in Isfahan province during 2011–2017.

## Materials and Methods

### Study design and setting

This descriptive study used insurance claim data from Health Insurance Organization (HIO) in Isfahan province to determine the amount of use and the cost of various outpatient diagnostic procedures for CVDs.

### Study participants and sampling

All claim data related to CVDs outpatient diagnostic procedures from 2011 to 2017 were used.

### Data collection tool and technique

Based on HIO experts' opinions, outpatient diagnostic procedures were carefully selected and the list of procedures was prepared. First, a list of all outpatient diagnostic procedures was extracted from the files including all procedures covered by Health Insurance Organization in 2011–2017. According to HIO experts' opinion, 48 procedures were included as CVD outpatient diagnostic tests. In the next step, similar procedures were grouped under one category, resulting in seven categories: ECG, echocardiography, exercise ECG stress test, Holter monitoring, pacemakers and ICDs, tilt table test, and myocardial perfusion scan. Then, the use and the cost of the aforementioned procedures were extracted from HIO claim data.

Afterward, by using the findings regarding the use and frequency of CVD outpatient diagnostic tests for those covered by HIO in Isfahan province, the use and the cost were estimated for the entire population in that province. This can be justified by two reasons. First, about one-third of people were covered by HIO. Second, this population included various social classes

such as government employees, villagers, self-insured individuals, foreigners, and those who did not have any other insurance plans. Thus, they could be considered as an appropriate representative and the findings could be generalized to the entire population of Isfahan province.

### Ethical consideration

This study received the required ethics approval from the Research Ethics Committee of Isfahan University of Medical Sciences, Isfahan, Iran with ethics code No. IR.MUI.RESEARCH.REC.1397.228.

## Results

Table 1 presents the use of outpatient diagnostic procedures for CVDs in Isfahan province from 2011 to 2017. The data indicate the ascending trend of such procedures as the number increased from 91,509 in 2011 to 603,898 in 2017. In all the years studied, ECG holds a greater share of procedures than other tests, although the percentage of its share has declined annually. Echocardiography and exercise ECG stress test hold the next ranks, in the order of their appearance. The tilt table test was the procedure with the smallest number in the years of interest.

Table 2 shows the cost of outpatient diagnostic procedures for CVDs during the 7-year period. The collected data indicate that such costs increased from 2011 to 2017, rising from 9,210,479,964 IRR (1,730,174 PPP\$) in 2011 to 283,306,368,035 IRR (20,316,122 PPP\$) in 2017. In all years, echocardiography had a greater share of the total cost than other tests. The share of echocardiography in the total cost was approximately 43% in 2011, but it increased to 53% in 2017. The increasing share of myocardial perfusion tests and pacemakers and ICDs is also significant in this period.

Table 3 presents the per capita use of outpatient diagnostic procedures for CVDs in Isfahan province per thousand people from 2011 to 2017. These data show an incremental trend. The highest use per capita is for ECG: 15.45 procedures per thousand people in 2011 increased to 72.97 procedures per thousand people by 2017. Echocardiography took the next place. In general, the per capita use of procedures increased from 18.75 to 116.51 procedures per thousand people in the mentioned period.

Table 4 shows the per capita cost of outpatient diagnostic procedures for CVDs in Isfahan province from 2011 to 2017. These data show an increasing trend, rising from 1,887,660 IRR (355 PPP\$) to 54,660,365 IRR (3920 PPP\$) per thousand people. The highest per capita cost is for echocardiography.

## Discussion

The results showed that from 2011 to 2017, the total use of outpatient diagnostic procedures for CVDs had increased about seven times. The highest use was related to ECG, echocardiography, and exercise ECG stress test in the studied years. The per capita use of procedures increased from 18.75 procedures per thousand people in 2011 to 116.51 procedures per thousand people in the same period. The total cost of outpatient diagnostic procedures for CVDs and its relative per capita number indicated an incremental trend in the 7-year period as the overall cost of these procedures increased 30.76 times (11.74 times adjusted with PPP conversion factor) in the period. The increase in the use of all CVD outpatient diagnostic procedures was consistent with the findings of Secretariat,<sup>[7]</sup> Lucas *et al.*,<sup>[8]</sup> and Hertz *et al.*<sup>[9]</sup> The increase in using echocardiography was also in line with the findings of Pearlman *et al.*<sup>[10]</sup> and Virnig *et al.*<sup>[11]</sup> The increasing trend observed in CVDs' costs was also in accordance with the findings of other studies, that is, Romiti *et al.*,<sup>[13]</sup> Roth *et al.*,<sup>[1]</sup> Ma *et al.*,<sup>[14]</sup> Siqueira *et al.*,<sup>[15]</sup> Toth *et al.*,<sup>[16]</sup> Tarride *et al.*,<sup>[17]</sup> and Alipour *et al.*<sup>[18]</sup> The increase in costs may be because of an overall increase in the number of total procedures as well as a change in price as relative value for physicians had substantially increased after the "Health Transformation Plan" (HTP) in 2014. Various reasons may be behind the rise in the total number of procedures. As stated before, the global prevalence of CVDs in the past three decades has increased by 93%<sup>[11]</sup> due to the increase in its associated risk factors such as sedentary lifestyle, unhealthy diet, smoking, and obesity. An aging population is also more susceptible to CVDs. Another reason might be the payment mechanisms to service providers. For instance, a payment system based on fee for service would increase the chance of unnecessary prescriptions or providing more costly services rather than less costly ones which is the phenomenon identified as supplier-induced demand. Choosing less appropriate tests by physicians, patients self-referring to multiple doctors for the same complaint, and unnecessary repeating can be mentioned as other reasons for the increase in the number of total procedures.<sup>[12]</sup>

Access issue may be another important reason justifying the rise in the use of outpatient CVDs tests. For instance, after the implementation of HTP, on one hand, health insurance coverage, and on the other hand, the number of facilities that had a contract with health insurance organizations increased. Moreover, with technological developments in recent years and the associated changes, doctors may use these new technologies to have more accurate and better quality diagnostic procedures (e.g., the latest technological advances in echocardiography) compared to older methods. It should be noted that due

**Table 1: The use of outpatient diagnostic procedures for CVDs**

Procedures	2011	2012	2013	2014	2015	2016	2017
Electrocardiography	75,399 (82.40%)	162,886 (77.71%)	182,828 (77.35%)	200,036 (71.18%)	303,899 (66.02%)	316,431 (63.75%)	378,217 (62.63%)
Echocardiography	8883 (9.71%)	33,884 (16.17%)	39,137 (16.56%)	54,012 (19.22%)	103,929 (22.58%)	126,455 (25.48%)	155,957 (25.83%)
Exercise ECG stress test	6801 (7.43%)	11,209 (5.35%)	11,858 (5.02%)	18,723 (6.66%)	33,595 (7.30%)	34,818 (7.01%)	41,937 (6.94%)
Holter monitoring	88 (0.10%)	638 (0.30%)	792 (0.34%)	2348 (0.84%)	3857 (0.84%)	4308 (0.87%)	8627 (1.43%)
Radionuclide myocardial perfusion scan	337 (0.37%)	985 (0.47%)	1744 (0.74%)	3277 (1.17%)	5348 (1.16%)	7090 (1.43%)	8790 (1.46%)
Pacemakers and ICDs	-	-	-	2506 (0.89%)	9418 (2.05%)	6925 (1.40%)	9997 (1.66%)
Tilt table test	-	-	-	134 (0.05%)	291 (0.06%)	360 (0.07%)	373 (0.06%)
Total	91,509 (100%)	209,603 (100%)	236,359 (100%)	281,036 (100%)	460,336 (100%)	496,388 (100%)	603,898 (100%)

Source: HIO and authors' calculations

**Table 2: The cost of outpatient diagnostic procedures for CVDs**

Procedures	2011	2012	2013	2014	2015	2016	2017
Electrocardiography (IRR)	2,821,446,401 (30.63%)	7,128,779,933 (23.91%)	9,139,555,957 (21.18%)	14,394,031,190 (17.19%)	27,976,441,969 (13.95%)	31,135,174,889 (12.15%)	33,265,655,243 (11.74%)
Electrocardiography (PPP\$)	530,004	1,173,810	1,042,283	1,399,019	2,408,662	2,454,877	2,385,506
Echocardiography (IRR)	3,965,994,106 (43.06%)	16,581,770,625 (55.61%)	23,167,138,401 (53.69%)	46,837,604,327 (55.95%)	113,183,974,265 (56.44%)	150,800,308,678 (58.84%)	150,396,394,108 (53.09%)
Echocardiography (PPP\$)	745,006	2,730,320	2,642,000	4,552,353	9,744,695	11,889,969	10,785,043
Exercise ECG stress test (IRR)	1,655,113,785 (17.97%)	3,084,502,171 (10.34%)	3,863,394,316 (8.95%)	5,445,649,887 (6.51%)	19,383,768,421 (9.67%)	21,841,906,882 (8.52%)	24,455,124,914 (8.63%)
Exercise ECG stress test (PPP\$)	310,910	507,888	440,585	529,287	1,668,866	1,722,142	1,753,696
Holter monitoring (IRR)	16,863,130 (0.18%)	161,953,908 (0.54%)	265,595,027 (0.62%)	1,098,576,786 (1.31%)	1,665,100,840 (0.83%)	1,987,530,382 (0.78%)	3,229,757,443 (1.14%)
Holter monitoring (PPP\$)	3168	26,667	30,289	106,776	143,359	156,708	231,608
Radionuclide myocardial perfusion scan (IRR)	751,062,541 (8.15%)	2,863,595,257 (9.60%)	6,715,267,531 (15.56%)	13,156,266,143 (15.72%)	25,691,980,528 (12.81%)	34,954,386,711 (13.64%)	44,180,442,407 (15.59%)
Radionuclide myocardial perfusion scan (PPP\$)	141,086	471,514	765,815	1,278,715	2,211,978	2,756,006	3,168,214
Pacemakers and ICDs (IRR)	-	-	-	2,600,007,143 (3.11%)	12,232,931,236 (6.10%)	15,065,847,206 (5.88%)	27,094,656,722 (9.56%)
Pacemakers and ICDs (PPP\$)	-	-	-	252,706	1,053,207	1,187,879	1,942,979
Tilt table test (IRR)	-	-	-	179,404,762 (0.21%)	394,837,935 (0.20%)	517,923,664 (0.20%)	684,337,198 (0.24%)
Tilt table test (PPP\$)	-	-	-	17,437	33,994	40,836	49,074
Total (IRR)	9,210,479,964 (100%)	29,820,601,894 (100%)	43,150,951,233 (100%)	83,711,540,238 (100%)	200,529,035,195 (100%)	256,303,078,412 (100%)	283,306,368,035 (100%)
Total (PPP\$)	1,730,174	4,910,199	4,920,970	8,136,293	17,264,760	20,208,418	20,316,122

Source: HIO and authors' calculations. Note: The PPP conversion factor in this study obtained from the World Bank<sup>[9]</sup>

**Table 3: Per capita use of outpatient diagnostic procedures for CVDs (per thousand people)**

Procedures	2011	2012	2013	2014	2015	2016	2017
Electrocardiography	15.45	33.06	36.75	39.83	59.92	61.79	72.97
Echocardiography	1.82	6.88	7.87	10.75	20.49	24.69	30.09
Exercise ECG Stress Test	1.39	2.28	2.38	3.73	6.62	6.80	8.09
Holter Monitoring	0.02	0.13	0.16	0.47	0.76	0.84	1.66
Radionuclide Myocardial Perfusion Scan	0.07	0.20	0.35	0.65	1.05	1.38	1.70
Pacemakers and ICDs	-	-	-	0.50	1.86	1.35	1.93
Tilt Table Test	-	-	-	0.03	0.06	0.07	0.07
Total	18.75	42.54	47.51	55.95	90.77	96.93	116.51

Source: HIO and authors' calculations

**Table 4: Per capita cost of outpatient diagnostic procedures for CVDs (per thousand people)**

Procedures	2011	2012	2013	2014	2015	2016	2017
Electrocardiography (IRR)	578,247	1,446,971	1,837,271	2,865,720	5,516,291	6,080,079	6,418,186
Electrocardiography (PPP\$)	109	238	210	279	475	479	460
Echocardiography (IRR)	812,818	3,365,701	4,657,152	9,324,939	22,317,195	29,448,296	29,017,074
Echocardiography (PPP\$)	153	554	531	906	1921	2322	2081
Exercise ECG stress test (IRR)	339,210	626,080	776,635	1,084,179	3,822,019	4,265,289	4,718,306
Exercise ECG stress test (PPP\$)	64	103	89	105	329	336	338
Holter monitoring (IRR)	3456	32,873	53,391	218,717	328,318	388,125	623,141
Holter monitoring (PPP\$)	1	5	6	21	28	31	45
Radionuclide myocardial perfusion scan (IRR)	153,928	581,241	1,349,930	2,619,292	5,065,849	6,825,895	8,524,055
Radionuclide myocardial perfusion scan (PPP\$)	29	96	154	255	436	538	611
Pacemakers and ICDs (IRR)	-	-	-	517,638	2,412,044	2,942,060	5,227,570
Pacemakers and ICDs (PPP\$)	-	-	-	50	208	232	375
Tilt table test (IRR)	-	-	-	35,718	77,853	101,140	132,034
Tilt table test (PPP\$)	-	-	-	3	7	8	9
Total (IRR)	1,887,660	6,052,866	8,674,379	16,666,203	39,539,569	50,050,886	54,660,365
Total (PPP\$)	355	997	989	1620	3404	3946	3920

Source: HIO and authors' calculations

to HTP, new relative values for physicians came to the practice; thus, the price of all procedures substantially increased. Thus, the substantial rise in cost, particularly in 2015, can be explained by the change in the price.

### Limitation and recommendation

One limitation of the present study was the lack of homogenous data and changes in procedures codes in the period under review.

### Conclusion

The use and the cost of outpatient diagnostic procedures for CVDs increased drastically during the study period (2011–2017). Since 2011, the number of procedures and their related costs have increased 6.6 and 30.76 times (11.74 times, adjusted with PPP conversion factor), respectively. Per capita use (per thousand people) of outpatient CVDs test in 2011 was 18.75, reaching 116.51 in 2017. Per capita cost (per thousand people) was 1,887,660 IRR (355 PPP\$) in 2011, reaching 54,660,365 IRR (3920 PPP\$) in 2017. This drastic rise might be because of an increase in the prevalence of CVDs, more widespread health insurance coverage, more access to tests, ineffective payment mechanisms, change in price, etc. Further research should be conducted to explain

the impact size of each factor. The findings may be a warning sign to the country's healthcare system and useful for public health policymakers. A need to take appropriate and timely action to control CVDs' burden and to cut the related costs should be emphasized.

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### Conflicts of interest

There are no conflicts of interest.

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