ARYA Atherosclerosis J

Original Article Open Access

The use and the cost of inpatient diagnostic and therapeutic procedures for cardiovascular diseases in public hospitals of Isfahan, Iran

Reza Rezayatmand [1], Davood Nasiri [2], Alireza Khosravi Farsani [3], Farzaneh Mohammadi-Sefiddashti [4*]

1- Health Management and Economics Research Center, Isfahan University of Medical Sciences, Isfahan, Iran
2- Department of Health Services Management, School of Management and Medical Information Sciences, Isfahan University of Medical Sciences, Isfahan, Iran
3- Hypertension Research Center, Isfahan Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran
4- Health Management and Economics Research Center, Isfahan University of Medical Sciences, Isfahan, Iran

Correspondence:

Farzaneh Mohammadi-Sefiddashti;
Health Management and Economics Research Center, Isfahan University of Medical Sciences, Isfahan, Iran;
Email:
mohammadi.farzaneh@gmail.com

Received: 2025-06-02
Accepted: 2025-11-01

How to cite this article:
Rezayatmand R, Nasiri D, Khosravi Farsani A, Mohammadi -Sefiddashti, F. **The use and the cost of inpatient diagnostic and therapeutic procedures for cardiovascular diseases in public hospitals of Isfahan, Iran.** ARYA Atheroscler. 2026; 22(1): 18-26.

DOI:
https://doi.org/10.48305/arya.2025.45299.3061

Abstract

BACKGROUND: Cardiovascular diseases (CVDs) are the most important cause of mortality and disability worldwide, causing substantial personal, social, and economic problems. This study determined the use and Cost of inpatient diagnostic and therapeutic CVD procedures in Isfahan from 2019 to 2021.

METHODS: This descriptive study covered a three-year period (2019–2021). Data were gathered from the Health Information System of two public hospitals that carried out these procedures (Chamran and Khorshid hospitals) in Isfahan, Iran. A list of procedures was carefully chosen according to experts' opinions, for which the use and cost of these procedures were extracted.

RESULTS: Coronary angiography demonstrated the highest annual average use (47.65%), while mitral valve repair showed the lowest (0.06%). The highest annual average total cost was seen in angioplasty (617,425,750,917 IRR), while the lowest was seen in mitral valve repair (2,375,305,232 IRR). Regarding cost per procedure, VSD surgery (409,107,479 IRR) had the highest annual average cost, while the lowest was seen in coronary angiography (56,340,938 IRR). A consistent upward trend in cost per procedure (in IRR) was observed across all procedures during the study period.

CONCLUSION: The majority of cardiovascular procedure costs are attributable to diagnosing and treating ischemic heart disease (IHD). Consequently, the increasing prevalence of CVDs particularly IHD coupled with the use of advanced technologies, imposes a significant financial burden on the healthcare system. This underscores the critical need for policy actions focused on lifestyle modification and primary prevention. Such measures are essential to curb rising costs and ensure healthcare system sustainability.

Keywords: Cardiovascular Diseases; Cost, Inpatients; Utilization Study; Angioplasty; Coronary Angiography

Introduction

Cardiovascular diseases (CVDs), which refer to a wide range of diseases that affect the heart and blood vessels[1], are the leading cause of death and premature mortality among non-communicable diseases (NCDs). These diseases also contribute significantly to disabilities, disease burden, and increased healthcare costs globally[2]. Low- and middle-income countries (LMICs) have experienced nearly 80% of deaths caused by CVDs[3]. In Iran, CVDs are the main cause of death[4]. According to the World Health Organization's reports of 2018 and 2020, total NCD deaths in Iran were 304,400 persons in 2016, accounting for 82% of all fatalities. Out of these deaths, 43% were due to heart diseases[5,6]. The Isfahan Cohort Study (ICS) reported high CVD-related incidence and mortality, serving as a crucial impetus for policymakers to prioritize CVD prevention and control programs[7].

CVDs incur both direct and indirect costs. Direct costs are related to medical care such as hospitalization, doctor visits, diagnostic tests, rehabilitation services, and medications. Indirect costs refer to productivity loss due to premature death and short-term or long-term disabilities, which decrease employment opportunities[8]. CVDs are expected to become a more significant burden in the future, particularly in developing countries. The economic impact of cardiovascular disease on households, health systems, and national income in developing countries can hinder poverty reduction[9].

The high prevalence of CVDs worldwide results in utilization of costly diagnostic and treatment procedures, which impose a significant cost burden on healthcare systems. It is estimated that the global cost of CVDs, approximately 863 billion USD in 2010, will increase by 22% in 2030, reaching 1,044 billion USD[10]. Other evidence also supports the increasing trend of cardiovascular disease costs[2,11–15].

Many studies have been conducted to calculate and report the costs of a varied range of diagnostic and medical CVD procedures; however, most have focused only on one or two procedures. Emamgholipour and Moeini (2022) and Osnabrugge et al. (2014) reported the cost of coronary artery bypass graft (CABG) surgery[16,17]. Zimmerman et al. (2021)[18], Ferreira et al. (2013)[19], Piot et al. (2022)[20], Tom and Sadri (2022)[21], and Ferket et al. (2018)[22] reported the mean cost of coronary CT angiography, average cost per patient for angioplasty, cost of implantable cardiac defibrillators, mean index hospitalization costs per patient for surgical aortic valve replacement (SAVR) and transcatheter aortic valve replacement (TAVR), and in-hospital costs for mitral valve repair and replacement procedures, respectively. It should be noted that each study has its own way of calculating and reporting costs, which makes comparisons between reported costs challenging.

Several studies have also reported the utilization rate of specific procedures. Ohri et al. (2022)[23], Kolte et al. (2016)[24], Westaway et al. (2021)[25], Hassan et al. (2010)[26], Roh et al. (2019)[27], Saad et al. (2021)[28], Zou et al. (2021)[29], Park et al. (2021)[30], and Dong et al. (2019)[31] reported the number of CABG procedures, the rate of coronary angiography, the number of pacemaker implants, the rate of percutaneous coronary intervention (PCI), the number of implantable cardioverter-defibrillator (ICD) insertions, the number of patients who underwent aortic valve replacement, the number of mitral valve replacements, the prevalence of patent ductus arteriosus (PDA) in infants, and the number of ventricular septal defects (VSD) and atrial septal defects (ASD), respectively. However, studies on the use of CVD procedures in recent years in Iran are lacking.

For more effective management of CVDs, a more accurate estimate of the usage and costs of diagnostic and medical CVD procedures is necessary. The aim of this study is to calculate and report the use and cost of inpatient diagnostic and therapeutic procedures for CVDs in Isfahan province during the years 2019–2021. This study encompasses a wide range of the most common in-hospital cardiovascular procedures.

Materials and Methods

This descriptive study aimed to determine the use and cost of inpatient diagnostic and therapeutic interventions for CVDs in the only two public hospitals performing such procedures (Chamran and Khorshid) in Isfahan, Iran, between 2019 and 2021. The study calculated the related costs from the payer perspective.

The list of inpatient CVD procedures was extracted from the Iranian Relative Value Units (RVUs) for physicians. It was then revised based on comments received from health insurance experts as well as cardiologists. Once the list of procedures was finalized, the utilization and cost-related data were collected from the Health Information System (HIS) of the corresponding hospitals.

The list of procedures included two diagnostic procedures : coronary angiography and peripheral vascular angiography and ten therapeutic procedures: angioplasty, coronary artery bypass grafting (CABG), pacemaker implantation, implantable cardioverter-defibrillator (ICD) insertion, aortic valve replacement, mitral valve replacement, mitral valve repair, and congenital heart defect surgeries such as atrial septal defect (ASD) surgery, ventricular septal defect (VSD) surgery, and patent ductus arteriosus (PDA) surgery.

It should be noted that while most patients underwent a single procedure, some patient records contained more than one RVU entry, as those patients had undergone multiple procedures during the same occasion. In these cases, to extract the use and cost data for single procedures, the proportion of each procedure within the combined records was determined based on data from single-procedure records.

The cost data were originally presented in Iranian Rials and then converted to U.S. dollars, adjusted using the purchasing power parity (PPP) conversion factor obtained from the World Bank[32].

Results

Table 1 depicts, the use, the cost and the cost per procedure (IRR&PPP$) of inpatient diagnostic and therapeutic procedures for CVDs during 2019-2021.

Across all years and procedures, the percentage of men undergoing inpatient diagnostic and therapeutic procedures for CVDs was higher than that of women. The age of patients who underwent these procedures ranged from 59 to 70 years.

As depicted in Table 1, coronary angiography demonstrated the highest annual average use (5,821 procedures; 47.65%) among all procedures, while mitral valve repair showed the lowest average use (5 procedures; 0.06%). In terms of cost, the highest annual average total cost was observed in angioplasty (617,425,750,917 IRR; 21,073,791 PPP$), while the lowest was seen in mitral valve repair (2,375,305,232 IRR; 87,176 PPP$). These procedures, on average, constituted 42.4% and 0.16% of the total expenditures, respectively.

Regarding cost per procedure, the highest annual average cost per procedure was observed in VSD surgery (409,107,479 IRR; 13,679 PPP$), while the lowest was seen in coronary angiography (56,340,938 IRR; 1,899 PPP$). The cost per procedure, measured in Iranian Rials (IRR), exhibited a consistent upward trend across all procedures during the study period. It should be noted that the cost per procedure comprised physician fees, pharmaceuticals, medical equipment, and bed rate.

The findings show that the use of inpatient diagnostic and therapeutic procedures for CVDs decreased in 2020 compared to the previous year for all procedures except ICD insertion. In 2021, for coronary angiography, angioplasty, pacemaker implantation, mitral valve replacement, mitral valve repair, and VSD surgery, the use of procedures increased compared to 2020 but did not reach the level of 2019, or remained nearly the same. For peripheral vascular angiography, CABG, and aortic valve replacement, utilization increased in 2021 compared to 2019. The number of ASD and PDA surgeries consistently decreased over the three years from 2019 to 2021. The use of ICD insertion consistently increased across

Table 1: The use and the cost of inpatient diagnostic and therapeutic procedures for CVDs during 2019-2021

Procedures	Year	The use of procedures	The total cost of procedures (IRR)	The total cost of procedures (PPP$)	Cost per procedure (IRR)	Cost per procedure (PPP$)	Average age	gender (percentage)
coronary angiography	2019	6,835	300,987,747,095	13,634,501	44,036,247	1,995	62	Male: 59% Female: 41%
	2020	4,900	256,300,226,496	8,999,954	52,306,169	1,837		
	2021	5,729	416,385,998,994	10,676,019	72,680,398	1,864		
annual average		5,821 (47.65%)	324,557,990,862 (22.29%)	11,103,491	56,340,938	1,899		
peripheral vascular angiography	2019	221	29,335,312,972	1,328,866	132,738,973	6,013	64	Male: 65% Female: 35%
	2020	211	33,709,390,179	1,183,701	159,760,143	5,610		
	2021	234	48,457,250,899	1,242,430	207,082,269	5,310		
annual average		222 (1.82%)	37,167,318,017 (2.55%)	1,251,666	166,527,128	5,644		
angioplasty	2019	4,271	531,551,342,074	24,078,845	124,455,945	5,638	66	Male: 67% Female: 33%
	2020	3,929	557,192,013,768	19,565,735	141,815,224	4,980		
	2021	4,248	763,533,896,910	19,576,793	179,739,618	4,608		
annual average		4,149 (33.96%)	617,425,750,917 (42.4%)	21,073,791	148,670,262	5,075		
CABG	2019	634	139,261,964,465	6,308,454	219,656,095	9,950	64	Male: 57% Female: 43%
	2020	549	145,435,103,865	5,106,937	264,909,115	9,302		
	2021	759	255,492,040,525	6,550,744	336,616,654	8,631		
annual average		647 (5.30%)	180,063,036,285 (12.37%)	5,988,712	273,727,288	9,294		
pacemaker implantation	2019	598	80,580,569,000	3,650,234	134,750,115	6,104	70	Male: 59 % Female: 41%
	2020	447	60,937,817,295	2,139,825	136,326,213	4,787		
	2021	581	110,349,975,621	2,829,342	189,931,111	4,870		
annual average		542 (4.44%)	83,956,120,639 (5.77%)	2,873,134	153,669,146	5,254		
implantable cardioverter defibrillator (ICD) insertion	2019	411	68,091,609,611	3,084,495	165,673,016	7,505	70	Male: 67% Female: 33%
	2020	457	84,180,214,954	2,955,979	184,201,783	6,468		
	2021	879	246,839,573,735	6,328,897	280,818,628	7,200		
annual average		582 (4.77%)	133,037,132,767 (9.14%)	4,123,123	210,231,142	7,058		
aortic valve replacement	2019	67	22,113,137,948	1,001,707	330,046,835	14,951	68	Male: 69% Female: 31%
	2020	48	16,336,862,382	573,667	340,351,300	11,951		
	2021	80	36,913,171,456	946,443	461,414,643	11,831		
annual average		65 (0.53%)	25,121,057,262 (1.73%)	840,606	377,270,926	12,911		

Continued Table 1: The use and the cost of inpatient diagnostic and therapeutic procedures for CVDs during 2019-2021

Procedures	Year	The use of procedures	The total cost of procedures (IRR)	The total cost of procedures (PPP$)	Cost per procedure (IRR)	Cost per procedure (PPP$)	Average age	gender (percentage)
	2019	62	17,171,552,047	777,857	276,960,517	12,546		
mitral valve replacement	2020	38	13,489,906,459	473,697	354,997,538	12,466	59	Male: 76% Female: 24 %
	2021	61	28,467,919,084	729,909	466,687,198	11,966		
annual average		54 (0.44%)	19,709,792,530 (1.35%)	660,488	366,215,084	12,326		
	2019	11	3,383,473,305	153,269	307,588,482	13,934		
mitral valve repair	2020	4	1,298,631,323	45,601	324,657,831	11,400	65	Male: 61% Female: 39%
	2021	6	2,443,811,068	62,659	407,301,845	10,443		
annual average		5 (0.06%)	2,375,305,232 (0.16%)	87,176	346,516,053	11,926		
	2019	37	3,129,169,661	141,749	84,572,153	3,831		
ASD surgery	2020	33	5,686,481,889	199,680	172,317,633	6,051	60	Male: 67% Female: 33%
	2021	30	7,278,205,361	186,611	242,606,845	6,220		
annual average		33 (0.27%)	5,364,618,970 (0.37%)	176,013	166,498,877	5,367		
	2019	60	18,314,576,503	829,635	305,242,942	13,827		
VSD surgery	2020	44	16,565,104,824	581,682	376,479,655	13,220	61	Male: 61% Female: 39%
	2021	52	28,371,191,721	727,429	545,599,841	13,989		
annual average		52 (0.43%)	21,083,624,349 (1.45%)	712,916	409,107,479	13,679		
	2019	54	6,840,630,945	309,875	126,678,351	5,738		
PDA surgery	2020	42	6,919,642,014	242,982	164,753,381	5,785	62	Male: 65% Female: 35%
	2021	30	5,297,661,282	135,831	176,588,709	4,528		
annual average		42 (0.34%)	6,352,644,747 (0.44%)	229,563	126,678,351	5,350		
	2019	13,261	1,220,761,085,626	55,299,487				
annual total use and cost of all procedures	2020	10,702	1,198,051,395,448	42,069,440				
	2021	12,689	1,949,830,696,656	49,993,107				

Table 2: The use and the cost of inpatient diagnostic and therapeutic procedures categorized by invasive and surgical procedures

Procedures	Year	The use of procedures	The total cost of procedures (IRR)	The total cost of procedures (PPP$)
Invasive Procedures	2019	12,336	1,010,546,580,752	45,776,941
	2020	9,944	992,319,662,692	34,845,194
	2021	11,671	1,585,566,696,159	40,653,481
Total (%)		33,951 (92.63%)	3,588,432,939,603 (82.14%)	121,275,616
Average		11,317	1,196,144,313,201	40,425,205
surgical Procedures	2019	925	210,214,504,874	9,522,546
	2020	758	205,731,732,756	7,224,246
	2021	1,018	364,264,000,497	9,339,626
Total (%)		2,701 (7.37%)	780,210,238,127 (17.86%)	26,086,418
Average		900	260,070,079,376	8,695,473
The use and cost of all procedures (2019-2021)		36,652	4,368,643,177,730	147,362,034

the study period. Based on these trends, most procedures exhibited a V-shaped three-year utilization pattern.

Findings also show that the total costs of all procedures (IRR) increased in 2021 compared to 2019, except for mitral valve repair and PDA surgery. Table 1 further indicates that the total cost of some procedures (IRR) such as coronary angiography, pacemaker implantation, aortic valve replacement, mitral valve replacement, mitral valve repair, and VSD surgery decreased in 2020. For peripheral vascular angiography, angioplasty, CABG, ICD insertion, and ASD surgery, the total costs (IRR) consistently increased during 2019–2021.

The total cost trend of all procedures (PPP$), except ASD surgery, decreased in 2020. For PDA surgery, the cost consistently decreased during 2019–2021. Overall, the findings show that the total cost of most procedures followed a V-shaped pattern over the three-year study period.

Table 2 shows the use and cost of inpatient diagnostic and therapeutic procedures categorized as invasive and surgical. Invasive procedures included coronary angiography, peripheral vascular angiography, angioplasty, pacemaker implantation, and ICD insertion. Surgical procedures consisted of aortic valve replacement, mitral valve replacement, mitral valve repair, ASD surgery, VSD surgery, PDA surgery, and CABG. Overall, 92.63% of procedures pertained to invasive interventions, while 7.37% were surgical. Invasive interventions accounted for 82.14% of the total costs, with surgical procedures constituting the remaining 17.86%. The average use of invasive procedures was 11,317 compared to 900 for surgical procedures over the three-year period. Similarly, the average total cost was 1,196,144,313,201 IRR (40,425,205 PPP$) for invasive procedures and 260,070,079,376 IRR (8,695,473 PPP$) for surgical procedures.

Discussion

The aim of this study was to identify the use and cost of inpatient diagnostic and therapeutic procedures for cardiovascular diseases in public hospitals in Isfahan, Iran, during 2019–2021. Chamran and Khorshid hospitals (the only two public hospitals performing CVD procedures) were studied.

The findings show that, as expected, the most frequently performed procedure was coronary angiography, the gold standard diagnostic test for ischemic heart disease (IHD), the most common heart condition. However, in terms of cost, our results indicate that 42.4% and 12.3% of the annual total cost for all procedures were attributable to angioplasty and coronary artery bypass graft (CABG), respectively. Both are therapeutic procedures for IHD. When these figures are combined with the share of coronary angiography (22.3% of the total annual cost), it becomes evident that approximately 77% of the total cost of all cardiovascular disease (CVD) procedures was related to the diagnosis and treatment of IHD. This demonstrates the

substantial cost burden of ischemic heart disease on society.

Regarding utilization trends, our findings show a V-shaped pattern for most procedures over the three-year study period, with a distinct decrease in 2020. This decline can be attributed to the peak of the COVID-19 pandemic during that year. Other studies have shown that the pandemic led to a global reduction in healthcare utilization[33]. Hospitals and medical centers postponed numerous elective and non-essential outpatient services to reallocate resources for COVID-19 patients. Consequently, although existing studies report an increasing trend for various procedures[24-26,29], we did not observe this pattern in our study, likely due to the concurrence of the study period with the COVID-19 pandemic.

The cost per procedure, measured in Iranian Rials (IRR), exhibited a consistent upward trend across all procedures during the study period. This can be primarily attributed to the annual increase in healthcare tariffs, which rose by 10%, 15%, and 46% in 2019, 2020, and 2021, respectively[34]. However, when the cost per procedure is adjusted for purchasing power parity (PPP), the increasing trend disappears for most procedures. These findings are not consistent with the results of other studies, which report a rising trend in cardiovascular disease costs[2,11–15]. This discrepancy can be explained by price suppression in the healthcare tariff-setting process, which occurs when tariffs are not increased in accordance with the real inflation rate.

From a payer perspective, accurately assessing the cost burden of cardiovascular disease (CVD) procedures requires comparing their total cost to the total funding received by the Isfahan University of Medical Sciences (IUMS), which includes social health insurance and patient out-of-pocket (OOP) payments. In 2021, this total funding for all health services in Isfahan province was about 18 trillion Iranian Rials (18,000,000,000,000 IRR)[35]. Our analysis found that 10.5% of this provincial healthcare expenditure was attributable to CVD procedures performed in these two academic hospitals. This figure highlights the substantial economic burden of CVDs, particularly ischemic heart disease (IHD), which accounted for most of these procedures.

Limitations

A limitation of this study is that it utilized data from hospital health information systems (HIS). These systems are not primarily designed for research purposes, which made data cleaning a very time-consuming process to ensure the data were suitable for addressing the research questions.

A key strength, however, is the inclusion of all inpatient cardiovascular procedures. This comprehensive scope provides policymakers with a complete view of the high economic burden of CVDs, thereby offering a strong evidence base for designing cost-containment strategies and preventive health policies.

Ethical consideration

This manuscript is part of a master's thesis approved by the Isfahan University of Medical sciences in 2021 with ethical code of IR.MUI.NUREMA.REC.1400.166.

Conclusion

The increasing prevalence of CVDs—particularly IHD—coupled with the use of more advanced diagnostic and treatment techniques, is placing a high cost burden on the health system. This underscores the importance of implementing policy actions focused on lifestyle modification and primary prevention to slow this trend. Failure to do so will confront the health system with a substantially higher burden in the near future, potentially resulting in an overstretched and unsustainable system.

Acknowledgements

The authors would like to thank the CEO and the managers of Chamran and Khorshid hospitals for their cooperation with the researchers in data collection.

Conflict of interests
The authors declare no conflict of interest.

Funding
This study was funded by Isfahan University of Medical Sciences, Isfahan, Iran with research code No. 3400673.

Author's Contributions
Study Conception or Design: RR, AKH, FMS
Data Acquisition: DN
Data Analysis or Interpretation: RR, DN, AKH, FMS
Manuscript Drafting: RR, FMS
Critical Manuscript Revision: RR, DN, AKH, FMS
All authors have approved the final manuscript and are responsible for all aspects of the work.

References

1. Gaidai O, Cao Y, Loginov S. Global Cardiovascular Diseases Death Rate Prediction. Curr Probl Cardiol. 2023 May;48(5):101622. https://doi.org/10.1016/j.cpcardiol.2023.101622
2. Roth GA, Mensah GA, Johnson CO, Addolorato G, Ammirati E, Baddour LM, et al. Global Burden of Cardiovascular Diseases and Risk Factors, 1990-2019: Update From the GBD 2019 Study. J Am Coll Cardiol. 2020 Dec 22;76(25):2982-3021. https://doi.org/10.1016/j.jacc.2020.11.010
3. Mensah GA, Roth GA, Fuster V. The Global Burden of Cardiovascular Diseases and Risk Factors: 2020 and Beyond. J Am Coll Cardiol. 2019 Nov 19;74(20):2529-32. https://doi.org/10.1016/j.jacc.2019.10.009
4. Sarrafzadegan N, Mohammmadifard N. Cardiovascular Disease in Iran in the Last 40 Years: Prevalence, Mortality, Morbidity, Challenges and Strategies for Cardiovascular Prevention. Arch Iran Med. 2019 Apr 1;22(4):204-10.
5. World Health Organization. Noncommunicable diseases: Progress monitor 2020. World Health Organization; 2020. Available from: https://www.who.int/publications/i/item/9789240000490
6. World Health Organization. Noncommunicable diseases country profiles 2018. Available from: https://www.who.int/publications/i/item/9789241514620
7. Givi M, Sarrafzadegan N, Garakyaraghi M, Yadegarfar G, Sadeghi M, Khosravi A, et al. Persian Registry Of cardioVascular diseasE (PROVE): Design and methodology. ARYA Atheroscler. 2017 Sep;13(5):236-44.
8. Mela A, Rdzanek E, Poniatowski ŁA, Jaroszyński J, Furtak-Niczyporuk M, Gałązka-Sobotka M, et al. Economic Costs of Cardiovascular Diseases in Poland Estimates for 2015-2017 Years. Front Pharmacol. 2020 Sep 8;11:1231. https://doi.org/10.3389/fphar.2020.01231
9. Gheorghe A, Griffiths U, Murphy A, Legido-Quigley H, Lamptey P, Perel P. The economic burden of cardiovascular disease and hypertension in low- and middle-income countries: a systematic review. BMC Public Health. 2018 Aug 6;18(1):975. https://doi.org/10.1186/s12889-018-5806-x
10. Rittiphairoj T, Bulstra C, Ruampatana C, Stavridou M, Grewal S, Reddy CL, et al. The economic burden of ischaemic heart diseases on health systems: a systematic review. BMJ Glob Health. 2025 Feb 12;10(2):e015043. https://doi.org/10.1136/bmjgh-2024-015043
11. Romiti S, Vinciguerra M, Saade W, Anso Cortajarena I, Greco E. Artificial Intelligence (AI) and Cardiovascular Diseases: An Unexpected Alliance. Cardiol Res Pract. 2020 Jun 27;2020:4972346. https://doi.org/10.1155/2020/4972346
12. Ma LY, Chen WW, Gao RL, Liu LS, Zhu ML, Wang YJ, et al. China cardiovascular diseases report 2018: an updated summary. J Geriatr Cardiol. 2020 Jan;17(1):1-8. https://doi.org/10.11909/j.issn.1671-5411.2020.01.001
13. Siqueira ASE, Siqueira-Filho AG, Land MGP. Analysis of the Economic Impact of Cardiovascular Diseases in the Last Five Years in Brazil. Arq Bras Cardiol. 2017 Jul;109(1):39-46. https://doi.org/10.5935/abc.20170068
14. Toth PP, Danese M, Villa G, Qian Y, Beaubrun A, Lira A, Jansen JP. Estimated burden of cardiovascular disease and value-based price range for evolocumab in a high-risk, secondary-prevention population in the US payer context. J Med Econ. 2017 Jun;20(6):555-64. https://doi.org/10.1080/13696998.2017.1284078
15. Tarride JE, Lim M, DesMeules M, Luo W, Burke N, O'Reilly D, Bowen J, Goeree R. A review of the cost of cardiovascular disease. Can J Cardiol. 2009 Jun;25(6):e195-202. https://doi.org/10.1016/s0828-282x(09)70098-4
16. Emamgholipour S, Moeini S. Comparison of the economic burden between coronary artery bypass grafting and percutaneous coronary intervention at a one-year follow-up. Iran Heart J. 2022;23(1):106-11.
17. Osnabrugge RL, Speir AM, Head SJ, Jones PG, Ailawadi G, Fonner CE, et al. Prediction of costs and length of stay in coronary artery bypass grafting. Ann Thorac Surg. 2014 Oct;98(4):1286-93. https://doi.org/10.1016/j.athoracsur.2014.05.073
18. Zimmerman ME, Batlle JC, Biga C, Blankstein R,

Ghoshhajra BB, Rabbat MG, et al. The direct costs of coronary CT angiography relative to contrast-enhanced thoracic CT: Time-driven activity-based costing. J Cardiovasc Comput Tomogr. 2021 Nov-Dec;15(6):477-83. https://doi.org/10.1016/j.jcct.2021.06.002

19. Ferreira C, Santana C, Paloni E, Bonachela F, Salles G, Brunet V, et al. Cost of angioplasty in Brazilian private hospitals. Value Health. 2013;16(3):A282-3.
20. Piot O, Defaye P, Lortet-Tieulent J, Deharo J-C, Beisel J, Vainchtock A, et al. Healthcare costs in implantable cardioverter-defibrillator recipients: A real-life cohort study on 19,408 patients from the French national healthcare database. Int J Cardiol. 2022 Feb 1;348:39-44. https://doi.org/10.1016/j.ijcard.2021.11.056
21. Tam DY, Sadri H. Annual Budget Impact Analysis Comparing Self-Expanding Transcatheter and Surgical Aortic Valve Replacement in Low-Risk Aortic Stenosis Patients. Can J Cardiol. 2022 Oct;38(10):1478-84. https://doi.org/10.1016/j.cjca.2022.06.005
22. Ferket BS, Ailawadi G, Gelijns AC, Acker MA, Hohmann SF, Chang HL, et al. Cost-Effectiveness of Mitral Valve Repair Versus Replacement for Severe Ischemic Mitral Regurgitation: A Randomized Clinical Trial From the Cardiothoracic Surgical Trials Network. Circ Cardiovasc Qual Outcomes. 2018 Nov 14;11(11):e004466. https://doi.org/10.1161/circoutcomes.117.004466
23. Ohri SK, Benedetto U, Luthra S, Grant SW, Goodwin AT, Trivedi U, et al. Coronary artery bypass surgery in the UK, trends in activity and outcomes from a 15-year complete national series. Eur J Cardiothorac Surg. 2022 Jan 24;61(2):449-56. https://doi.org/10.1093/ejcts/ezab391
24. Kolte D, Khera S, Dabhadkar KC, Agarwal S, Aronow WS, Timmermans R, et al. Trends in Coronary Angiography, Revascularization, and Outcomes of Cardiogenic Shock Complicating Non-ST-Elevation Myocardial Infarction. Am J Cardiol. 2016 Jan 1;117(1):1-9. https://doi.org/10.1016/j.amjcard.2015.10.006
25. Westaway S, Nye E, Gallagher C, Tu SJ, Clarke N, Hanna-Rivero N, et al. Trends in the use, complications, and costs of permanent pacemakers in Australia: A nationwide study from 2008 to 2017. Pacing Clin Electrophysiol. 2021 Feb;44(2):266-73. https://doi.org/10.1111/pace.14161
26. Hassan A, Newman A, Ko DT, Rinfret S, Hirsch G, Ghali WA, et al. Increasing rates of angioplasty versus bypass surgery in Canada, 1994-2005. Am Heart J. 2010 Nov;160(5):958-65. https://doi.org/10.1016/j.ahj.2010.06.052
27. Roh SY, Choi JI, Kim MS, Cho EY, Kim YG, Lee KN, et al. Trends in the use of implantable cardioverter-defibrillators for prevention of sudden cardiac arrest: A South Korean nationwide population-based study. Pacing Clin Electrophysiol. 2019 Aug;42(8):1086-94. https://doi.org/10.1111/pace.13741
28. Saad AM, Kassis N, Isogai T, Gad MM, Ahuja KR, Abdelfattah O, et al. Trends in Outcomes of Transcatheter and Surgical Aortic Valve Replacement in the United States (2012-2017). Am J Cardiol. 2021 Feb 15;141:79-85. https://doi.org/10.1016/j.amjcard.2020.10.065
29. Zhou S, Egorova N, Moskowitz G, Giustino G, Ailawadi G, Acker MA, et al. Trends in MitraClip, mitral valve repair, and mitral valve replacement from 2000 to 2016. J Thorac Cardiovasc Surg. 2021 Aug;162(2):551-562.e4. https://doi.org/10.1016/j.jtcvs.2019.12.097
30. Park J, Yoon SJ, Han J, Song IG, Lim J, Shin JE, et al. Patent ductus arteriosus treatment trends and associated morbidities in neonates. Sci Rep. 2021 May 21;11(1):10689. https://doi.org/10.1038/s41598-021-89868-z
31. Dong Y, Zhang Y, Tong S, Jiang Z, Xu Z, Li X, et al. Analysis of the Seasonal Trend of Congenital Heart Defects. J Pediatr. 2019 Apr;207:29-33.e1. https://doi.org/10.1016/j.jpeds.2018.12.024
32. PPP conversion factor, private consumption (LCU per international $) - Iran, Islamic Rep. Available from: https://data.worldbank.org/indicator/PA.NUS.PRVT.PP?locations=IR
33. Moynihan R, Sanders S, Michaleff ZA, Scott AM, Clark J, To EJ, et al. Impact of COVID-19 pandemic on utilisation of healthcare services: a systematic review. BMJ Open. 2021 Mar 16;11(3):e045343. https://doi.org/10.1136/bmjopen-2020-045343
34. Iran Health Insurance Organization, Inpatient Documents Statistics System. https://ihio.gov.ir/
35. Budget law of the Islamic Republic of Iran for the fiscal year 1400 (2021), Approved by the Islamic Consultative Assembly· Plan and Budget Organization, Tehran, Iran.