

**Cost-Effectiveness and Clinical Success of Cardiac Treatments for Yemeni Patients in India (2016-2023)**

فعالية التكلفة والنجاح السريري لعلاجات القلب للمرضى اليمنيين في الهند  
(2023-2016)

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### ABSTRACT

Cardiovascular diseases are the leading cause of mortality globally .

Objective: To evaluate the cost-effectiveness and clinical outcomes of cardiac treatments .

Materials and methods: We retrospectively reviewed the reports of 1650 Yemeni patients with congenital heart defects and ischemic heart diseases treated between January 2016 and December 2023 in India. The collected data were analyzed and estimated rates, means and standard deviations, t-test was used and p-value < 0.05 was considered as statistically significant .

Results: Most of the patients were males with (60.6%) while females were (39.4%). Additionally, most of the patients (57.6%) were of age group > 15 years followed by the age group ≤ 15 years with .(%42.4)

The average treatment cost for ischemic heart disease 5800 US Dollar, while the average treatment cost of congenital heart defect was 7200 US Dollar .

Overall, the average treatment cost per patient in US Dollars was approximately {6,500}. The mean success rate for patients with congenital heart defect 89.7% and mean success rate for patients with ischemic heart disease 92.5% .

Conclusion: The high success rates and affordable costs make India an optimal destination for cardiac patients.

**Key words:** Cost-effectiveness, Cardiac treatment, Yemeni patients, India

فعالية التكلفة والنجاح السريري لعلاجات القلب للمرضى اليمنيين في الهند  
(2023-2016)

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ملخص البحث:

سنة بنسبة (42.4%). تكلفة العلاج المتوسطة  
لأمراض القلب الإقفارية كانت 5800 دولار  
أمريكي، بينما تكلفة العلاج المتوسطة للعيوب  
القلبية الخلقية كانت 7200 دولار أمريكي. ويشكل  
عام، كانت التكلفة المتوسطة لكل مريض حوالي  
6500 دولار أمريكي. معدل النجاح المتوسط  
للمرضى ذوي العيب القلبي الخلقى كان 89.7%،  
ومعدل النجاح لأمراض القلب الإقفارية كان 92.5%

الاستنتاج: معدلات النجاح المرتفعة والتكاليف  
المقبولة تجعل من الهند وجهة مثلى لمرضى  
القلب.

الكلمات المفتاحية: الجدوى الاقتصادية،  
علاج القلب، المرضى اليمنيين، الهند.

أمراض القلب والأوعية الدموية هي السبب  
الرئيسي للوفاة على مستوى العالم.

يهدف البحث إلى تقييم الجدوى الاقتصادية  
والنتائج السريرية لعلاجات القلب.

المواد وطريقة البحث: راجعنا بشكل رجعي  
تقارير 1650 مريضاً يمنياً لديهم عيوب قلبية خلقية  
وأمراض قلب إقفارية، تم علاجهم بين يناير 2016  
وديسمبر 2023 في الهند. تم تحليل البيانات  
المجمعة وحساب المعدلات والمتوسطات والانحراف  
المعياري، وأستخدم اختبار الت، واعتبر أن قيمة  
 $P < 0.05$  ذات دلالة إحصائية.

النتائج: كان معظم المرضى من الذكور بنسبة  
(60.6%)، بينما الإناث كن بنسبة (39.4%).  
بالإضافة لذلك، كان أغلب المرضى (57.6%) في  
الفئة العمرية أكبر من 15 سنة، تليها الفئة  $\geq 15$

## 1. Introduction:

Cardiovascular diseases (CVDs) are the leading cause of mortality globally, responsible for a significant number of deaths and disabilities. In 2021 alone, CVDs accounted for 20.5 million deaths, comprising approximately one-third of all global deaths [1]. While cardiovascular conditions were traditionally considered **diseases of affluence**, this is no longer the case. Over three-quarters of CVD-related deaths occur in low- and middle-income countries [2].

The healthcare system in Yemen before the war was fragile marked by inadequate infrastructure, limited financial resources, and severe accessibility challenges [3].

Public health spending was critically low at 1.3% of **Gross Domestic Product (GDP)**, which is far below regional and global averages with government expenditure covering only 41.8% of total healthcare costs of which 58.2% came from private sources primarily out-of-pocket payments [4]. Also, nearly 30% of total health spending went toward treatment abroad due to the lack of advanced medical services domestically for urgent and complicated cases [5].

Cardiovascular diseases, in particular heart failure, are on the top as a cause of mortality worldwide, including medium and low income countries [6].

India has emerged as a premier destination for medical tourism, particularly for cardiac care, offering a unique combination of advanced medical technologies, skilled professionals, and comparatively affordable costs. Treatments ranging from congenital defect corrections to complex coronary interventions are available with success rates comparable to those in high-income countries [7]. Additionally, India's proactive engagement in health tourism and international patient services makes it accessible and attractive for Yemeni patients.

From a financial standpoint, India presents a cost-effective option. The average cost of cardiac procedures in India is significantly lower than in Europe or North America. For instance, a coronary artery bypass graft (CABG) in India costs approximately \$5,000 to \$8,000, compared to \$70,000 or more in the United States [7]. This affordability, combined with high clinical standards, has made India a viable alternative for many low- and middle-income country patients, including Yemenis.

**Objective:** To evaluate the cost-effectiveness and clinical outcomes of cardiac treatments for Yemeni patients treated in India between 2016 and 2023.

## Materials and methods:

We retrospectively reviewed the reports of 1650 Yemeni patients with congenital heart defects (children aged  $\leq 15$  years) and ischemic heart diseases (adults aged  $> 15$  years) treated between January 2016 and December 2023 in accredited cardiac hospitals and centers recognized by the Yemeni Medical Attaché in Mumbai, India. The patients were 1000 males and 650 females.

The collected data were:

- Clinical data: diagnosis, treatment modalities, outcomes, complications.
- Financial data: total costs, cost per patient.
- Outcomes: procedural success rates.

The collected data were tabulated and statistical analysis was done by estimating rates, means and standard deviations, t-test was used and p-value  $< 0.05$  was considered as statistically significant.

## Results:

The Table 1 highlights the distribution of patients by gender, showing most of the patients were male patients with 1000 (60.6%) while female patients were 650 (39.4%). In addition Table 1 reveals that, most of the patients 950 (57.6%) were of age group  $> 15$  years followed by the age group  $\leq 15$  years with 700 (42.4%).

**Table 1: Distribution of study patients and their age groups related to diagnosis and frequency**

Variables	Diagnosis	No	%
<b>Gender:</b>			
<b>Males</b>		1000	60.6
<b>Females</b>		650	39.4
<b>Age groups (years):</b>			
$\leq 15$	- Congenital heart defects.	700	42.4
$> 15$	- Ischemic heart diseases.	950	57.6

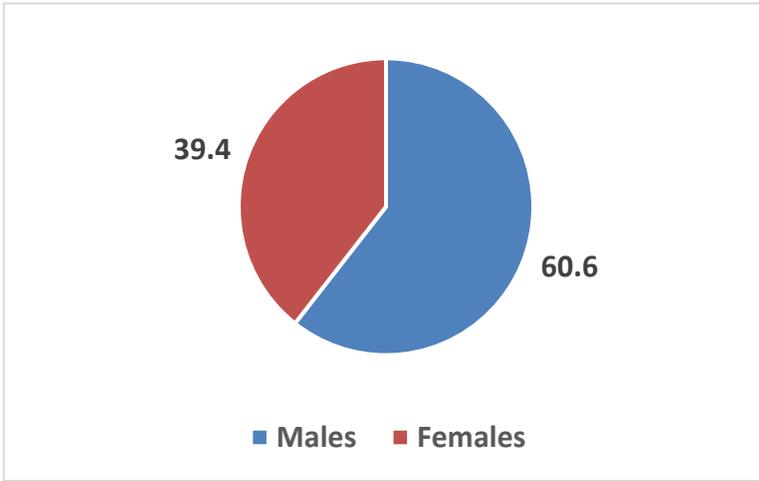


Figure 1: Proportion of study patients related to sex

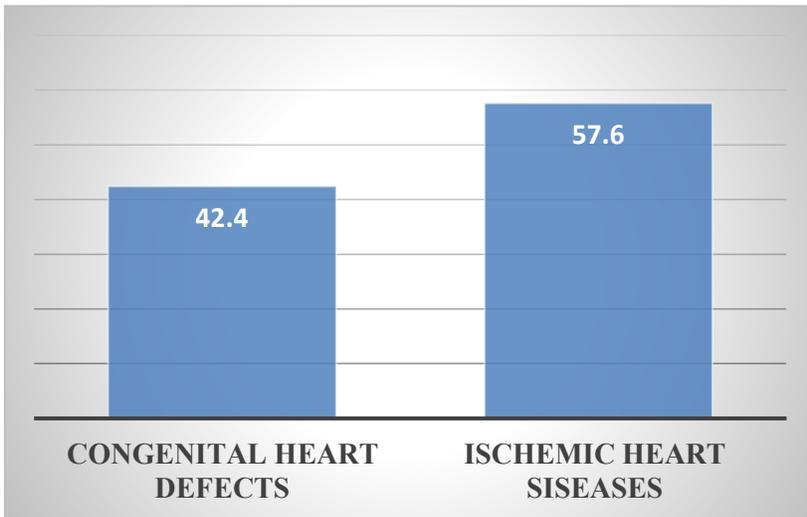


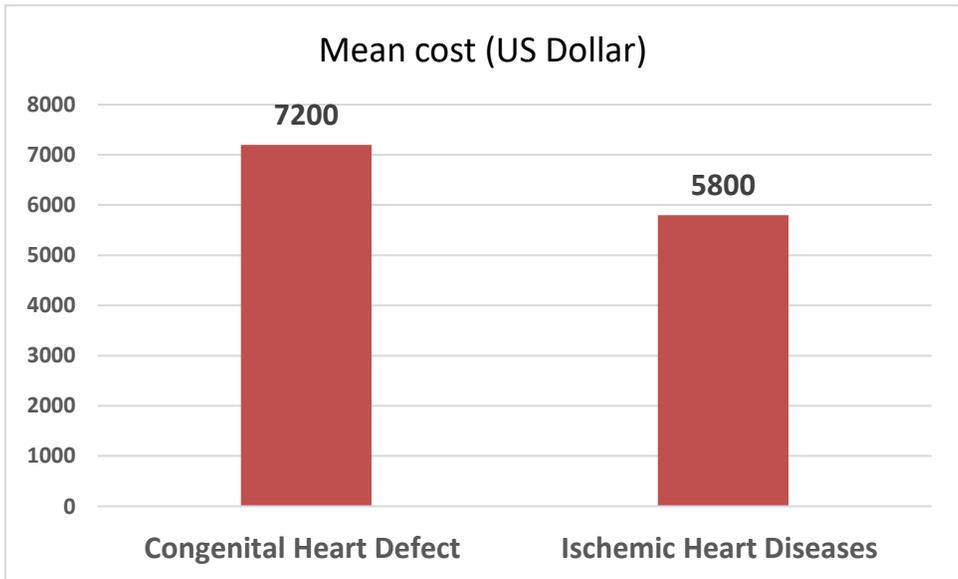
Figure 2: Proportion of diagnosis among the study patients

Table 2 and Figure 3 revealed that the average treatment cost for ischemic heart disease 5800 US Dollar, while the average treatment cost of congenital heart defect was 7200 US Dollar as shown in Table2. Overall, the average treatment cost per patient in US Dollars was approximately  $\{5800 + 7200 = 13000; \text{ then } 13000/2 = 6,500\}$ . In addition, they highlight that congenital defect surgeries are more expensive than ischemic interventions.

Additionally, Table 2 and Figure 4 showed the mean success rate for patients with congenital heart defect 89.76% (95% CI: 89.58% - 89.94%), and mean success rate for patients with ischemic heart disease 92.49% (95% CI: 92.36% - 92.62%), p-value: 0.0001. The statistical analysis confirms that the difference in success rates between patients with congenital heart defect and patients with ischemic heart disease is statistically significant.

**Table 2: Cost and Success Rates by Treatment Category**

Treatment Category	mean cost (USD)	Success Rate	95% Confidence Interval of the Difference	P-value
Congenital Heart Defect	7200	89.76	95% CI: 89.58-89.94	0.0001
Ischemic Heart Diseases	5800	92.49	95% CI: 92.36-92.62	



**Figure 3: Mean treatment cost of children with congenital heart defects and adults with ischemic heart diseases**

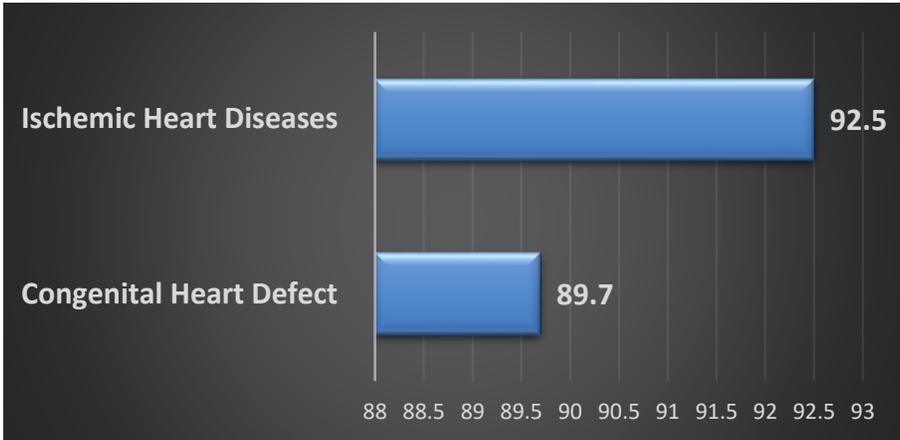


Figure 4: Distribution of mean success rates among

## Discussion:

India is the preferred destination for medical tourism. India's medical tourism is amongst the fastest growing subsectors in the industry. According to many research reports including the report by Klynveld Peat Marwick Goerdeler (KPMG) [8] with its key differentiating factors of extremely competitive pricing, highly trained doctors, high quality care and availability of a range of treatments, India has realized the potential of medical tourism and positioned itself as one of the largest service providers in this region" [9].

In our present study, the distribution of patients by gender, showing most of the patients were male patients with 1000 (60.6%) while female patients were 650 (39.4%).

Regitz-Zagrosek et al [10] reported in their published study that ischemic heart disease has been perceived as a primarily "male disease", and "evidence-based" clinical standards have been based on male pathophysiology and outcomes in basic and clinical research.

Several studies report clear sex discrepancies in clinical outcomes for IHD patients treated either with conservative or invasive approach [10,11]. IHD remains one of the leading causes of morbidity and mortality across the globe [12].

Regarding the variation of frequency between gender and CHD, several studies reported that there is a predominance of male sex among patients with CHD compared to females [13,14,15]. However, other studies have reported that the number of CHD cases was greater among females [15,16], or there was no gender difference [17]. This difference may be due to geographical, racial, socio-economic, ecological, and genetic factors, or it could be due to more male reporting due to cultural eccentricity [18].

We found in our present study, the average treatment cost for ischemic heart disease 5800 US while the average treatment cost of congenital heart defect was 7200 US Dollar.

With regards to IHD patients in urban regions, in China, Ding et al [19] analyzed the direct inpatient costs of IHD in one single tertiary hospital in Xi'an City and reported that the mean hospitalization expenditures were USD 6,791.38 in 2015 (USD 6,481.00 in 2012). However, the samples of Ding et al.'s study [19] were recruited from only one tertiary hospital and might not represent the urban population in China.

In the present study, we found the average treatment cost per patient was approximately 6,500 US Dollars. In addition, they highlight that congenital defect surgeries are more expensive than ischemic interventions.

Congenital heart disease is among the top five non-communicable causes of death and disability in children living in low to middle income countries. Sixty-nine percent of children with congenital heart disease die before their first year of life [20]. A country that is well-known to provide surgical procedures at extremely low costs is India [21].

This is facilitated by a thriving local manufacturing industry in India that produces low-cost cardiac surgery equipment and devices. Additionally, India performs approximately 27,000 surgeries annually, allowing them to benefit from economies of scale that enable bulk purchase of supplies and efficiently distribute fixed costs [21,22].

In our current study, we found the mean success rate of surgical treatment for patients with congenital heart defect 89.76% (95% CI: 89.58% - 89.94%), and mean success rate for patients with ischemic heart disease 92.49% (95% CI: 92.36% - 92.62%), p-value: 0.0001. The statistical analysis confirms that the difference in success rates between patients with congenital heart defect and patients with ischemic heart disease is statistically significant.

When comparing our results to the larger multi-center studies [23,24,25], it can be noted that the mortality rate of congenital heart defect ranging from 1.7% to 3.1% and that mean the success rate range between 98.3% to 96.9%.

Stellin et al [24] reported that the mortality rate of surgical treatment for patients with congenital heart defect ranging from 0% to 15.3%, so the success rates ranged from 100% to 85%.

Ischemic heart disease is a common cause of heart failure [26] and is associated with increased mortality [26,27,28]. Although the prevalence of risk factors for developing ischemic heart disease is lower in low-income countries, the relative incidence and case-fatality rate of ischemic heart disease is often higher. This is possibly caused by a combination of poor risk factor control and worse health system quality [29,30].

### Conclusion:

Cardiac treatments for Yemeni patients in India from 2016 to 2023 demonstrated outstanding clinical outcomes and cost-effectiveness. The high success rates and affordable costs make India an optimal destination for Yemeni cardiac patients.

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## المجلة مفهرسة في المواقع الآتية :



2025	2024	2023	2022	2021	العام
0.5978	0.3068	0.3759	0.1954	0.2692	معامل أرسيف
1.81	1.55	1.25	1.73	1.60	معامل التأثير العربي