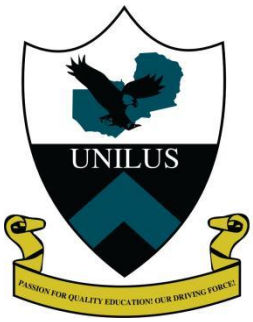


UNIVERSITY OF LUSAKA

SCHOOL OF POSTGRADUATE STUDIES

ASSESSING THE COST EFFECTIVENESS AND COST UTILITY OF HEALTH EXPENDITURE ON OPERATIVE CARDIAC PATIENTS IN ZAMBIA.

BY

ERIC CHISENGA

MBAHCM 23119791.

2025

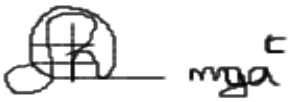
A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, UNIVERSITY OF LUSAKA, IN PARTIAL FULFILLMENT OF THE AWARD OF THE MASTER OF BUSINESS ADMINISTRATION IN HEALTHCARE MANAGEMENT.

DECLARATION

I, Eric Chisenga, hereby declare that this dissertation titled "**Assessment of the Cost-Effectiveness and Cost-Utility of Health Expenditure on Operative Cardiac Patients in Zambia**" is my original work and has not been submitted for a degree or diploma at any other university or institution.

To the best of my knowledge and belief, this dissertation contains no material previously published or written by another person, except where due reference is made in the text. Any assistance or sources utilized during the preparation of this work have been appropriately acknowledged.

This research has been conducted in accordance with the ethical guidelines and regulations of the University of Lusaka and the National Health Research Authority.

Signed: 

Eric Chisenga.

Supervisors signature: 

Name: Dr. Fredrick Chitangala, PhD.

DEDICATION.

This dissertation is dedicated to the honour and memory of my late father, Mr Kelvin Monso Chisenga ,my mother, Mrs Dorah Chibwe Chipendano Chisenga and my elder brothers and sisters for their unwavering love, understanding, encouragement, and sacrifices that have been the foundation of my journey.

My Mentors: For their invaluable guidance and inspiration, which have shaped both my academic and personal growth.
Patients and Healthcare Workers: Whose resilience and dedication motivated the pursuit of this study, reminding me of the importance of improving healthcare access and outcomes.

May this work serve as a tribute to the power of perseverance and the impact of collective effort in advancing effective healthcare systems in Zambia.

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Finally, to everyone whose contributions, both big and small, have played a role in the completion of this thesis, please accept my sincere thanks. This work stands as a testament to the collective efforts of all who have believed in and supported me along the way.

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LIST OF ACRONYMS/ABBREVIATIONS.

1. CABG: Coronary Artery Bypass Grafting
2. CHD: Congenital Heart Disease
3. CUA: Cost-Utility Analysis
4. CVD: Cardiovascular Diseases
5. DALY: Disability-Adjusted Life Year
6. GDP: Gross Domestic Product
7. GRZ: Government of the Republic of Zambia
8. HALE: Health-Adjusted Life Expectancy
9. HFS: Health Financing Strategy
10. HIC: High-Income Countries
11. ICER: Incremental Cost-Effectiveness Ratio
12. ICU: Intensive Care Unit
13. ICUR: Incremental Cost-Utility Ratio
14. LMIC: Low- and Middle-Income Countries
15. MBAHCM: Master of Business Administration in Healthcare Management
16. MCS: Mental Composite Score
17. MOH: Ministry of Health
18. NCD: Non-Communicable Diseases
19. NHH: National Heart Hospital
20. NHP: National Health Policy
21. PCS: Physical Composite Score
22. PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses
23. QALY: Quality-Adjusted Life Year
24. RCT: Randomized Controlled Trial
25. SAVR: Surgical Aortic Valve Replacement
26. SDS: Self-Rating Depression Scale
27. SF-36: Short Form 36-Item Health Survey
28. SHI: Social Health Insurance
29. SPSS: Statistical Package for Social Sciences

30. TAVR: Transcatheter Aortic Valve Replacement
31. UTH: University Teaching Hospital
32. VRC: Variable Resource Contexts
33. WHO: World Health Organization

ABSTRACT.

Cardiovascular diseases (CVDs) are a leading cause of mortality globally, disproportionately affecting low- and middle-income countries like Zambia. This study evaluates the cost-effectiveness and cost-utility of government health expenditure on operative cardiac patients at Zambia's National Heart Hospital. Utilizing a quantitative research approach and retrospective cohort design, the study analyzed economic viability through metrics such as incremental cost-effectiveness ratios (ICERs) and quality-adjusted life years (QALYs). Data were collected from 70 operative cardiac patients, assessing direct medical costs, societal burdens, and clinical outcomes.

The results reveal significant variability in cost-effectiveness across different cardiac conditions. Interventions for mitral stenosis and sternal cleft were found to be highly cost-effective, while conditions such as atrial and ventricular septal defects presented data gaps, limiting comprehensive analysis. The findings highlight the importance of robust economic evaluations in resource-limited settings, offering insights into optimal resource allocation and prioritization in cardiac care.

This study informs healthcare policy by providing evidence-based recommendations for improving the efficiency and equity of health expenditures. The research supports Zambia's national goals of achieving universal health coverage and reducing the cardiovascular disease burden. These insights emphasize the need for sustained investments in cardiac care infrastructure and workforce development to ensure a cost-effective and sustainable healthcare system.

CHAPTER ONE

Introduction and Background.

1.1 Chapter Introduction

This chapter lays the foundation for the study, which examines the cost-effectiveness and cost-utility of health expenditure on cardiac surgery in Zambia. It begins by contextualizing the critical burden of cardiovascular diseases in Zambia, highlighting their rising prevalence and the resultant strain on the healthcare system. The chapter further explores the economic challenges faced by low- and middle-income countries like Zambia in allocating limited healthcare resources efficiently to high-cost interventions such as cardiac surgery.

The background discusses the broader implications of investing in cardiac care within the Zambian healthcare framework, including its potential to improve patient outcomes, enhance quality of life, and contribute to long-term health system sustainability. By framing the research problem, objectives, and relevance, this chapter establishes the imperative of evaluating the economic viability of cardiac surgery in Zambia. It serves as a foundation for understanding the study's scope, approach, and the critical questions it seeks to address.

1.2 Introduction.

Cardiovascular diseases remain a significant public health concern globally, with a substantial burden on healthcare systems, economies, and individuals. There is an urgent need to focus on implementing existing cost-effective policies and interventions if the world is to meet the targets for Sustainable Development Goal number Three (3) and achieve a 30% reduction in premature mortality due to non-communicable diseases. (Vos T., Lim S.S., Abbafati C. Global burden of 369 diseases and injuries in 204 countries and

territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2020;).

Over 80 million adults in the United States (US) suffer from some form of cardiovascular disease, accounting for close to one in three US deaths annually and over $300 billion in direct and indirect costs.With increasing health care expenditures and a health policy environment promoting greater efficiency and value-based care,the relevance of evaluating cost-effectiveness in cardiac surgery has become more critical. The growing focus on cost-effectiveness research in cardiac surgery can be shown by an increasing number of publications in the field. (Anderson JL, Heidenreich PA, Barnett PG, Creager MA, Fonarow GC, Gibbons RJ, et al. Acc/aha statement on cost/value methodology in clinical practice guidelines and performance measures: A report of the American college of cardiology/American heart association task force on performance measures and task force on practice guidelines. J Am Coll Cardiol. 2014; 63: 2304–2322).

The limited access to quality healthcare, inadequate funding, and lack of sufficient medical expertise continue to hinder the provision of appropriate care for patients in Africa. Furthermore, the high mortality rates associated with congenital heart diseases procedures in Africa highlight the need for more investment in cardiac surgery infrastructure and training programs. However, efforts made by the international community in providing humanitarian aid and establishing cardiac surgery programs in Africa have improved the prognosis and outcomes for congenital heart disease patients profoundly.(Awuah WA, Adebusoye FT, Wellington J, Ghosh S, Tenkorang PO, Machai PNM, Abdul-Rahman T, Mani S, Salam A, Papadakis M. A reflection of Africa's cardiac surgery capacity to manage congenital heart defects: a perspective. Ann Med Surg (Lond). 2023 Jul 8;85(8):4174-4181.)

In Zambia, cardiovascular diseases are among the leading causes of morbidity and mortality, with cardiac surgery being a critical component of the healthcare response. However, with limited resources and competing healthcare needs, it is essential to perform an economic evaluation of health financing on cardiac

surgery patients in Zambia to optimize resource allocation and improve health outcomes.

Economic Evaluation (Health economics) is an emerging field in the research for health to aid resource allocation decisions, and this is not an exception in the assessment of its cost-effectiveness when compared to other interventions put forth. Economic Evaluation is defined as comparing both the costs and effects of two or more interventions. Measures of Effectiveness in the assessment of the health sector are classified as changes to that of the patient's health, and these can be captured in various ways such as changes to life expectancy, quality of life, and relief of symptoms. This paves the way to carry out cost-utility studies, one where the effects of the intervention are assessed in terms of the gain in a single health outcome. This is compared to a cost-effectiveness study in which the effects are assessed in a broad manner, usually using indicators of health.

The situation is no different in developing countries, and Zambia is not an exception. The Government of the Republic of Zambia (GRZ) states that the country is stricken with high levels of poverty, malnutrition, and disease - more than 50% of the population live on or below the poverty line. The Ministry of Health (MOH) in Zambia has health as the most significant of its human requirements sectors, hence ensuring that in the National Planning and Budgeting guidelines a significant amount of the National Budget is allocated to the sector. The cost of ill-health is severe both to households and the overall economy. The World Health Report (2002) stated that when households become victims of illness, they suffer three kinds of losses: loss of health, loss of income, and increased cost of health care. The combined effect is to trap the affected households in a downward spiral of worsening health and poverty. The poor are not only the primary victims of ill-health but also its major cause, as the lack of effective health care perpetuates the poverty trap (The World Health Report, 2002).

An economic evaluation of health expenditure on operative cardiac patients in Zambia is critical for several reasons. Firstly, it can inform resource allocation

decisions within the healthcare system, ensuring that limited funds are allocated to interventions that provide the greatest health benefits for the population. Secondly, it can guide policymakers in prioritizing investments in cardiac care infrastructure, workforce training, and preventative measures to reduce the burden of Cardiovascular diseases, help justify investments in cardiac care to donors, policy-makers, and other stakeholders.

In Zambia, the mission of the Ministry of Health is to provide equitable access to cost-effective, quality health services that are as close to the family as possible, with a focus of Leaving No One Behind. The Ministry's drive towards quality universal health coverage is strengthened by the decentralization of health services to local the authorities. The Ministry aims to improve the health status of people in Zambia and contribute to increased productivity and socioeconomic development. (https://www.moh.gov.zm). This research, therefore, will focus on an economic evaluation of the cost of each cardiac surgical procedure at the National Heart Hospital.

1.3 **Background of the Study.**

Cardiovascular diseases, including operative cardiac conditions, are a leading cause of morbidity and mortality globally, posing significant challenges to healthcare systems, particularly in low and middle-income countries like Zambia. The increasing prevalence of cardiac conditions, coupled with limited resources and competing healthcare priorities, necessitates a comprehensive economic evaluation of health expenditure on operative cardiac patients in Zambia.

The Health Financing Strategy (HFS) 2017-2027 provides a framework for improving and developing health financing in Zambia to contribute to overall health system goals and objectives. The strategy aligns with the country's vision of having a healthy nation by 2030 as per National Health Strategic Plan (2017-2021), the seventh National Development Plan, and the National Health Policy

(NHP) 2012.The NHP emphasizes the need to mobilize health resources through equitable and sustainable means for the provision of cost-effective quality health care as close to the family as possible. This Health Financing Strategy provides an integrated approach that complements various national policies in addressing present and future health financing challenges.

The challenges health financing faces stem from bottlenecks within and outside the health sector. At the macro-fiscal level, the increase in domestic and external debt limits the ability to increase the fiscal space for health through government funding. The high debt-service ratio will make it difficult for government to re-prioritize its expenditures to health and other social sectors. Further, the high levels of informality, unemployment, and widespread poverty limit the prospects to generate additional revenue through taxes and the Social Health Insurance (SHI). Further, the country's attainment of the lower-middle-income country status will result in most donors reducing their support to the health sector and government as a whole. As a result, the sector needs a comprehensive health financing system to provide an action-oriented agenda on how to mobilize additional resources amid the macro-fiscal challenges.

The purchasing of health care has two dimensions. The first is determining what services should be purchased. The World Health Organization (WHO) 2010 World Health Report unpacks this into three components comprising share of the total population to be covered, the range of services to be provided and the cost-sharing mechanisms. The range of services covered is often specified in the benefit package. In the public sector, Ministry of Health has previously developed the basic health care package at different levels of the health care system. The delivery of these services is premised on the effective implementation of the packages, which cover health conditions to be attended to at different tiers of the health sector. The current Ministry of Health package emphasizes primary and preventive health care and is available to the entire population with exceptions of the defence forces that have their own health facilities. The hospital-level packages focus on specialized services which, despite being comprehensive, are not fully implemented due to lack of resources. Often, the basic health care package is used for strategic planning rather than purchasing services. (Republic of Zambia ,Ministry of Health,

HEALTH FINANCING STRATEGY: 2017 – 2027,Towards Universal Health Coverage for Zambia).

Based on this background of limited government health financing in Zambia, this research seeks to do an economic evaluation of government financing of the costly cardiac surgical procedures done at the National Heart Hospital.

1.4 Statement of the problem.

Despite efforts to improve cardiac care, there remains a lack of empirical evidence regarding the economic implications and clinical outcomes associated with healthcare expenditure on operative cardiac patients in Zambia. The absence of data-driven insights hampers informed decision-making, resource allocation, and the optimization of cardiac care delivery within the Zambian healthcare context. Key issues that warrant investigation include:

- Economic Burden
- Treatment Disparities
- Cost-Effectiveness of Treatment Modalities
- Clinical Outcomes
- Resource Allocation

Addressing these challenges requires a comprehensive economic evaluation of health expenditure on operative cardiac patients in Zambia. By conducting a rigorous analysis, this study aims to generate empirical evidence that informs policy formulation, enhances clinical practice, and improves the overall quality of care for cardiac surgery patients in Zambia.

1.5 Research Objectives and Research Question.

1.5.1 Main Objective

To assess the cost-effectiveness and cost-utility of health expenditure on operative cardiac patients in Zambia.

1.5.2 **Specific objectives**

1. To evaluate the direct and indirect costs of operative cardiac surgery compared to non-surgical management.

2. To assess the health outcomes and quality-adjusted life years (QALYs) gained from cardiac surgery interventions.

3. To calculate incremental cost-effectiveness ratios (ICERs) and cost-utility ratios (ICURs) for cardiac surgery interventions.

1.6.3 Research Hypotheses

1. Null Hypothesis (H_0): Government health financing for cardiac surgery in Zambia is not cost-effective and does not result in significant cost-utility benefits compared to non-surgical interventions.

2. Alternative Hypothesis (H_1): Government health financing for cardiac surgery in Zambia is cost-effective and results in significant cost-utility benefits compared to non-surgical interventions.

1.7 Significance of The Study

This research has significant implications for healthcare policy and practice in Zambia and other Low-Middle Income Countries facing similar challenges in delivering cardiac care. By providing robust evidence on the cost-effectiveness and cost-utility of operative cardiac interventions, this study can inform strategic investments, policy formulation, and clinical decision-making, ultimately improving access to high-quality cardiac care and reducing the burden of cardiovascular diseases in Zambia.

1.8 Scope of the study

I. Population/Geographical location: The study will focus on operative cardiac patients in Zambia who have undergone surgical interventions for cardiac conditions at the National Heart Hospital.

II. Treatment Modalities: The study will evaluate the cost-effectiveness and cost-utility of different treatment modalities for operative cardiac patients, including medications, surgical interventions, cardiac rehabilitation programs, and follow-up care at the National Heart Hospital.

III. Healthcare Expenditure: The study will assess healthcare expenditure associated with operative cardiac care at the National Heart Hospital, including direct medical costs and indirect costs.

IV. Economic Evaluation: The study will conduct a comprehensive economic evaluation to determine the cost-effectiveness and cost-utility of different healthcare expenditure strategies for operative cardiac patients at the National Heart Hospital.

III. Clinical Outcomes: The study will investigate the impact of healthcare expenditure on operative cardiac patients' clinical outcomes, quality of life, functional status, and long-term prognosis at the National Heart Hospital.

Chapter Two

Literature Review

2.1 Chapter Introduction

This literature review aims to provide an overview of existing evidence on the cost-effectiveness and cost-utility of operative cardiac interventions globally, with a focus on implications for healthcare policy and practice in Zambia. It will start with a review of the global burden of cardiovascular diseases (CVDs) and the significance of surgical interventions such as valve replacements, followed by methodologies commonly employed in cost-effectiveness and cost-utility analyses, highlighting key metrics like Incremental Cost-Effectiveness Ratios (ICERs) and Quality-Adjusted Life Years (QALYs). This is followed by an examination of empirical studies on operative cardiac procedures in both high-income and low- and middle-income countries, with a focus on how resource constraints shape the economic viability of such interventions. The review culminates with a synthesis of findings specific to Zambia, identifying gaps in the literature and opportunities for policy and healthcare system improvements. This structured approach aims to contextualize the need for economic evaluation in Zambia's cardiac care landscape while underscoring its potential to guide efficient resource allocation and improve patient outcomes.

2.0 Review of Relevant Literature

Cardiovascular diseases (CVDs) constitute a significant global health challenge, with increasing prevalence and substantial economic burden in both high-income countries (HICs) and low- and middle-income countries (LMICs) alike. Operative cardiac procedures, including coronary artery bypass grafting (CABG), valve replacement, and congenital heart defect repair, are essential interventions in managing CVDs and improving patient outcomes. However, the cost-effectiveness and cost-utility of health expenditure on operative cardiac

patients in LMICs, such as Zambia, remain understudied areas of research. Cardiovascular diseases impose a substantial economic burden on healthcare systems and societies worldwide. According to the World Health Organization (WHO), CVDs are the leading cause of death globally, accounting for an estimated 17.9 million deaths annually. Moreover, the economic costs associated with CVDs, including healthcare expenditures, productivity losses, and premature mortality, are projected to escalate in the coming decades, particularly in LMICs where healthcare resources are limited (World Health Organization, 2017).

Several studies have assessed the cost-effectiveness of operative cardiac procedures in different healthcare settings. For example, a systematic review by Neumann et al. (2017) evaluated the cost-effectiveness of CABG compared to medical therapy for patients with stable coronary artery disease. The authors concluded that CABG was a cost-effective intervention, particularly for patients with more severe disease or high-risk features. Similarly, studies by Hammill et al. (2017) and Shaw et al. (2016) demonstrated the cost-effectiveness of valve replacement surgery for patients with valvular heart disease, with favourable long-term outcomes and quality-adjusted life years (QALYs) gained compared to medical management alone.

Despite the proven efficacy of operative cardiac procedures, their cost-effectiveness and cost-utility in LMIC settings face unique challenges. Limited healthcare infrastructure, human resources, and financial constraints often hinder the delivery of timely and equitable cardiac care in these contexts (Dougherty et al., 2019). Moreover, disparities in access to cardiac interventions, inadequate preoperative screening and diagnostics, and postoperative complications contribute to variability in outcomes and cost-effectiveness across different healthcare settings (Atkins et al., 2016).

In Zambia, where the burden of CVDs is rising, and healthcare resources are constrained, assessing the cost-effectiveness and cost-utility of health expenditure on operative cardiac patients is of paramount importance. Despite recent efforts to improve cardiac care infrastructure and access to essential

interventions, such as the establishment of specialized cardiac centers and training programs for healthcare professionals, challenges remain in ensuring optimal allocation of resources and maximizing health outcomes for cardiac patients (Sani et al., 2020).

With regards to healthcare resources, healthcare finance is facilitated by domestic resources and contributions from partners. The budget allocation for the year 2021 was K9.2 billion and it was increased to K12,4 billion in 2022 representing 35% increment. In 2023, the total budget for Ministry of Health was K16.1 billion, representing a percentage increment of 30%, out of which K14.7 billion was from GRZ and K1.3 billion from Cooperating Partners. The Personal Emolument was allocated K7.7 billion while the Non-Personal Emolument had a total budget of K8.4 billion which is inclusive of K1.3 billion from Cooperating Partners through their direct budget support. It is important to note that several donors provide off-budget support which also made significant contributions to the success of the Ministry in 2023. (Press Statement: Ministry of Health 2023 End of Year Performance Highlights: https://www.moh.gov.zm). In 2021, the Government of the Republic of Zambia, opened the country's first ever Government owned specialized cardiac hospital, called the National Heart Hospital (NHH) which provides super specialized cardiac care in Paediatric Cardiology, Adult Cardiology and Cardiac-thoracic Surgery. According to the ministry of Health (MOH), approximately 23% of all deaths in Zambia are attributed to Non-Communicable Diseases or NCDs in short of which cardiovascular diseases (CVDs) form a major part.

Collaborating with stakeholders, the Government has embarked on a mission to combat NCDs by promoting healthier lifestyles, cancer screening, delivering effective treatment through training specialist doctors such as cardiologists (and cardiac surgeons), and providing rehabilitation and palliative care to those who need it. In 2023, the National Heart Hospital conducted 29 open heart surgeries and performed 93 angiograms and five kidney transplants. This contributed to a reduction of Government expenditure for treatment abroad. (Press Statement: Ministry of Health 2023 End of Year Performance Highlights; https://www.moh.gov.zm)

World-wide, the average cost of cardiac surgery in general is considered to be very high. With regards to the Zambian context, the exact costs of each surgical intervention funded by the government is not known and so is the exact budgetary allocation to the National Heart Hospital for both medical and surgical management of cardiovascular diseases.

In conclusion, the literature reviewed highlights the importance of assessing the cost-effectiveness and cost-utility of health expenditure on operative cardiac patients, both globally and in LMIC settings such as Zambia. While operative cardiac procedures have demonstrated clinical efficacy in improving patient outcomes, their economic implications, particularly in resource-constrained settings, require further investigation. By informing healthcare policy and practice, evidence on the cost-effectiveness and cost-utility of cardiac interventions can contribute to more efficient resource allocation, improved access to care, and ultimately, better health outcomes for cardiac patients in Zambia and similar contexts.

2.3 **Empirical Literature Review**

Healthcare systems worldwide face challenges in allocating resources efficiently, particularly in addressing high-cost and complex medical procedures such as cardiac surgery. Government financing plays a pivotal role in determining access, affordability, and outcomes of such interventions. This review synthesizes empirical studies on the cost-effectiveness and cost utility of government financing for cardiac surgery globally, with a focus on Africa and Zambia, providing insights into trends, methodologies, and outcomes.

Globally, several studies have evaluated the cost-effectiveness of cardiac surgery using metrics such as incremental cost-effectiveness ratios (ICERs), quality-adjusted life years (QALYs), and disability-adjusted life years (DALYs). A landmark study by Cowper et al. (2020) analysed cardiac interventions in high-income countries, finding that coronary artery bypass grafting (CABG)

yielded ICERs ranging from $10,000 to $20,000 per QALY, well below the World Health Organization (WHO) threshold for cost-effectiveness.

In countries like the United States and the United Kingdom, robust health financing systems have enabled extensive studies on cardiac surgery's economic impact. For instance, a study by McMurray et al. (2019) highlighted that government subsidies for heart valve surgeries led to a 30% reduction in out-of-pocket expenses, significantly improving patient access. Additionally, comparative studies in European nations by Grönholm et al. (2021) demonstrated that minimally invasive surgeries had superior cost-effectiveness ratios compared to traditional methods.

In countries like the United States and the United Kingdom, robust health financing systems have enabled extensive studies on cardiac surgery's economic impact. For instance, a study by McMurray et al. (2019) highlighted that government subsidies for heart valve surgeries led to a 30% reduction in out-of-pocket expenses, significantly improving patient access. Additionally, comparative studies in European nations by Grönholm et al. (2021) demonstrated that minimally invasive surgeries had superior cost-effectiveness ratios compared to traditional methods. In low- and middle-income countries, limited health budgets limit the uptake of advanced cardiac interventions. However, studies from regions such as South Asia and Latin America indicate that government-supported cardiac programs can be cost-effective. For example, Kumar et al. (2018) found that funding from the Indian National Health Mission for cardiac surgeries yielded an ICER of $5,000 per QALY, highlighting the importance of targeted subsidies. Africa faces a growing burden of cardiovascular disease due to urbanization, lifestyle changes, and limited preventive care. Studies such as those by Oladipo et al. (2020) highlight the disproportionate impact of these diseases on health systems, with cardiac surgical procedures both rare and costly.

The cost-effectiveness and cost-utility of cardiac surgery have been extensively studied, particularly in high-income countries where advanced healthcare systems and robust data collection mechanisms allow for detailed analyses.

Studies often employ methodologies such as incremental cost-effectiveness ratios (ICERs) and quality-adjusted life years (QALYs) to evaluate the economic viability of cardiac interventions. A study by McGowan et al. (2019) demonstrated that coronary artery bypass grafting (CABG) is cost-effective when compared to medical therapy alone, with an ICER well below the willingness-to-pay threshold in developed economies like the United States. Research by Kolh et al. (2021) on valve replacement surgeries found that transcatheter aortic valve replacement (TAVR) is more cost-effective for high-risk patients compared to surgical aortic valve replacement (SAVR), yielding higher QALYs despite higher initial cost. In a meta-analysis by Epstein et al. (2020), cardiac surgeries consistently ranked as cost-effective interventions when measured against alternative treatments, particularly for long-term improvements in survival and quality of life.

In Africa, studies on the cost-effectiveness of cardiac surgery are limited, often due to resource constraints and data scarcity. However, existing research highlights significant challenges and opportunities in implementing cardiac care.

A study conducted in South Africa by Kengne et al. (2018) evaluated the cost-utility of CABG and found it to be marginally cost-effective in resource-limited settings, with an ICER of $7,500 per QALY gained. The study emphasized the importance of reducing costs through locally manufactured surgical materials and optimizing postoperative care. Ndifon et al. (2017) examined outcomes of valve repair surgeries in Nigeria and reported that while these surgeries are economically viable for middle-income populations, subsidization or health insurance coverage is critical for broader accessibility. In Rwanda, a pilot study by Rusingiza et al. (2019) on the cost-effectiveness of paediatric cardiac surgery through international partnerships demonstrated favourable outcomes, but sustainability was highlighted as a significant concern without increased local capacity.

A study on the, “Cost-effectiveness of surgical interventions in low-income and middle-income countries: a systematic review and critical analysis of recent evidence” by Martilord Ifaenyich et al.(2024) discussed that many Low to Middle

Income Countries are currently undergoing the development and implementation of national surgical plans, which intend to offer a strategy for surgical care strengthening. Evidence on the comparative value in costs and benefits of surgical interventions will be crucial to inform such plans, supporting the development of Universal Health Coverage benefit packages, and informing the allocation of limited resources to maximise societal welfare.

This review synthesized the most recent evidence on the cost-effectiveness of surgeries in LMICs published over the last decade and provided information on the comparative cost-effectiveness between surgical and common public health interventions. Based on the WHO recommended cost-effectiveness threshold linked to a country's GDP per capita, most surgeries (assessed) can be classified as very cost-effective. Moreover, many low-complexity surgical interventions compared favourably with common public health interventions, making them a best-buy consideration for policy-makers aiming to improve population health.

The review consolidated critical information dispelling the economic myths around surgery. This further adds to the wider evidence on the value of surgical care to address a large unmet surgical need across many parts of the world, and its implications for individuals, communities and societies. To optimise efficiency, policy-makers must seek ways to maximise benefits and minimise costs, or at least in adopting new interventions, they should ensure that the marginal cost of a new technology attracts commensurate marginal benefit compared with current practice. For example, based on the findings, investments in new expensive robotic technology for prostatectomy may not represent best value for money in a resource-constraint setting if the gain in clinical benefit is only modest compared with the standard laparoscopic prostatectomy.

Similarly, depending on the population health profile of a given country, allocative decisions must take into consideration the comparative effectiveness of curative interventions versus other worthwhile public health interventions that target disease prevention. Such considerations are not only instructive for country-level policy-makers but also important for international donors.

In this study, A descriptive analysis of study characteristics and results was performed for all included studies. The Incremental Cost-Effectiveness Ratio (ICER) which is the standard metric for expressing the result of cost-effectiveness evaluation of a pair of alternative interventions and is therefore the most reported cost-effectiveness metric was used. However, as the ICER (also referred to as the Incremental Cost-Utility Ratio in CUAs) is a summary measure for a specific pair of comparators defined from the outset of a study, it is only useful in relation to the pair for which it was estimated. To allow for an assessment of the cost-effectiveness of a stand-alone procedure and compare cost-effectiveness across multiple individual surgeries (from different studies) and against otherwise unrelated traditional public health services, an average cost-effectiveness ratios (ACERs) for individual interventions was calculated, by dividing the cost of intervention per patient by the total benefit per patient.

Therefore, for each pair of comparators evaluated, two separate ACERs were computed, except where a surgical procedure was compared against a non-surgical alternative, which was dropped from the analysis. To determine the cost-effectiveness of interventions, the costs per unit of benefit (QALY, DALY, or HALE) were compared against the respective country GDP per capita, in accordance with the suggestions of the World Health Organization (WHO) Commission on Macroeconomics and Health.

Interventions with cost per unit of benefit greater than three times the GDP per capita were considered not cost-effective; less than three times the GDP per capita were considered cost-effective; less than the GDP per capita were considered very cost-effective. The ACERs were further compared with costs per DALY for common traditional public health interventions, derived from the DCP2,16 and inflated to 2022 United States Dollar equivalents. Meta-analyses were not conducted due to heterogeneity in study population characteristics (e.g, disease severity, gender, age and comorbidities) and model design (e.g, model type, perspectives, cycle length and horizon). To facilitate data presentation, identified surgical procedures were clustered into countries of study, specialties and procedure groups. Distributions or spreads of costs per

unit of benefit across country/specialty/procedure clusters were computed and presented using ranges and medians.

A narrative synthesis was used in presenting the results of this study, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Notable limitations of this study included the following; the limited geographical spread of the identified studies restricted the extent to which the evidence could be used for broader decision-making, yet only small variation in the underlying costs associated with the production of surgeries across Low to Middle Income Countries that would impact the country-specific cost-defectiveness ratios were expected and the heterogeneity of cost-effectiveness data presented in the included articles, made it not feasible to perform meta-analyses across surgical specialties, or for specific surgical interventions across different Low to Middle Income Countries. Finally, the findings in the review of this study may have been impacted by publication bias whereby identified procedures were skewed towards only the cost-effective interventions due to the lower tendency for studies with non-cost-effective outcomes to be published in the literature.

To address this concern, a gray literature search was performed. Policy-makers and funding organizations must consider that the information presented (ranges and medians) across clusters (countries, specialties and procedure groups) represents only values among interventions that have been evaluated and published in those clusters in the last decade, and does not encompass the full breadth of possible interventions in those clusters.

African governments have adopted diverse models to finance cardiac care. In South Africa, the introduction of the National Health Insurance (NHI) scheme significantly expanded access to surgeries such as CABG and valve replacements. Hlatshwayo et al. (2021) reported ICERs of $12,000 per QALY for these interventions, suggesting high cost-effectiveness relative to the country's GDP per capita. Few African countries have conducted cost-utility analyses of cardiac surgery. However, a study conducted in Kenya by Mwangi et al. (2019) found that government-funded surgical interventions for rheumatic

heart disease achieved an ICER of less than US$8,000 per QALY. Similarly, a study in Nigeria (Akinola et al., 2020) highlighted that public-private partnerships reduced treatment costs by 25%, thereby improving affordability.

Barriers include inadequate healthcare infrastructure, workforce shortages, and inconsistent funding. A comprehensive review by Tadele et al. (2021) emphasized the need for region-specific strategies, such as telemedicine and task-shifting, to optimize resource utilization.

A study on the Cost-effectiveness analysis of pediatric cardiac surgery for common lesions in Rwanda published in the international journal of cardiology volume 421 by Vangai C. Mlambi, et al, provided the following insights highlighted below.

Only 3 % of children in sub-Saharan Africa with congenital heart disease (CHD) have access to life-saving surgery. There is an urgent need to scale up the volume of cardiac procedures. Cost-utility analysis can assess the health economic impacts of performing congenital heart surgery in this region.

A cost-utility analysis comparing surgical intervention and medical management for a weighted case mix of the four most common CHDs in Rwanda was performed with a Markov model constructed to simulate the course of each strategy.

Probability of peri-operative complications was derived from the local paediatric cardiac surgery program and risks of long-term outcomes from large, published cohort studies. Micro-costing was used to calculate expenses from program cost data. Health benefits were measured in quality-adjusted life years (QALYs). Deterministic and probabilistic sensitivity analysis was performed. Incremental cost-effectiveness ratios (ICER) were compared to a willingness-to-pay threshold three times the GDP per capita of Rwanda (USD$2898·60).

From this study, surgical intervention provided 17·15 additional discounted QALYs compared to medical management for an extra USD$6738·23. The

ICER for surgical intervention was USD$269·52/QALY. Increasing the cost of surgery raised the ICER to a maximum of USD$580/QALY. In the probabilistic sensitivity analysis, surgery was cost-effective 100 % of the time including at one-times GDP per capita. The conclusion was that surgical intervention for common CHD in Rwanda is very cost-effective. The initial cost of surgery is compensated for by decades of additional life years. Increasing case complexity and decreasing the initial cost of surgery can make surgery even more cost-effective.

Traditionally, the focus of paediatric healthcare expenditure in sub-Saharan Africa has been in the prevention and treatment of infectious disease. However, this region is facing rising rates of mortality and morbidity from congenital birth defects. Congenital heart disease (CHD) is the most common birth defect in the region and is now the seventh leading cause of death among children in low- and middle-income countries (LMICs). Outcomes are often lethal, with 69 % of deaths in the first year of life. Children who survive may develop long-term disabilities. Careful planning and allocation of limited resources will be required to address this dual burden of disease.

Cardiac surgery for moderate to severe CHD increases life expectancy, improves cardiovascular function, and enhances quality of life. Despite this, among the 2·7 million children with CHD in sub-Saharan Africa, only an estimated 3 % have access to surgical treatment. As a result, while the burden of CHD in high-income countries (HICs) has declined by 61 % in the past 27 years, in sub-Saharan Africa, they have increased by 4·6 % to 40·3 % depending on the region due to late detection and limited access to definitive treatment.

Currently, there are twenty-five (25) cardiac centers known to offer paediatric cardiac surgery in sub-Saharan Africa. However, these centers are insufficient to fully address the burden of CHD. Expanding cardiac surgery services is a resource-intensive endeavour requiring a robust referral system, training of specialized personnel, and a reliable supply chain for surgical consumables. As a result, cardiac surgery is often considered a niche service and has not been

prioritized in national health plans. For many children, medical management is their only treatment option with grave outcomes.

Cost-effectiveness analysis (CEA) is a methodology that assesses the differential costs and benefits among management options. Net costs are compared to net health benefits, such as life years, cases averted or reduced hospitalizations and quantified in terms of an incremental cost-effective ratio (ICER). A sub-type of cost-effectiveness analysis is cost-utility analysis (CUA) where the net health benefits of interest in this type of analysis are quality adjusted life years (QALYs) which captures both morbidity and mortality, making this analysis useful for population-level decision-making. The results can be used to decide whether the intervention is worth the investment within a specific economic context. It is frequently used by publicly financed healthcare systems to guide policy and spending decisions.

Cost-effectiveness analyses for CHD surgery performed by LMICs are limited. We perform an a CUA comparing surgical intervention and medical management for common CHD lesions in sub-Saharan Africa using early outcomes data from Rwanda's in-house paediatric cardiac surgery program. The results of this study can be used to guide national financing for cardiac surgery and provide a model for other countries in sub-Saharan Africa to perform a similar analysis for their healthcare planning needs.

This study is the first known CUA comparing surgical and medical management for CHD in sub-Saharan Africa using primary data from an in-house paediatric cardiac surgery program in Rwanda. It shows that even when the long-term risks of surgical treatment are considered, repair of Atrial Septal Defect, Ventricular Septal Defect, Patent Ductus Arteriosus, and Coarctation of the Aorta is very cost-effective compared to medical management. The additional expenses are well compensated by the extra 17 QALYs surgery provides. By this study, paediatric cardiac surgery for common congenital lesions performed by an in-house program in Rwanda is very cost-effective. The economic value is comparable to humanitarian missions and other public health interventions

that have reduced infant mortality, motivating sustained investment into the expansion of cardiac surgery services.

A study on the Cost-effectiveness of Humanitarian Paediatric Cardiac Surgery Programs in Low- and Middle-Income Countries by Marcello Carderelli et al (2018), provided the following insights: Of the nearly $38 billion donated in 2016 by Western governments, international public health organizations, and philanthropic corporations, most was channeled toward global health interventions that were deemed to be highly cost-effective or good for local public health goals. Most supported global health interventions involve infectious disease prevention or treatment, improvements in maternal and childcare, or other social public health projects (e.g. sanitation and clean water). In contrast, "...the development and delivery of surgical and anaesthesia care in LMICs [low- and middle-income countries] has been nearly absent from the global health discourse." Surgical treatment of congenital heart disease (CHD), a large and poorly met surgical need in those countries, is absent from the global conversation as well.

Accordingly, the primary goal of this study was to investigate the cost-effectiveness in US dollars per unit of health of a humanitarian intervention consisting of global paediatric cardiac surgery program building. The secondary goal was to produce an enhanced quantifier of the impact of global health care humanitarian efforts by considering what we refer to as the humanitarian footprint. The study defined this measure of value as the potential improvements in the individualized components of the United Nations Human Development Index (HDI), life expectancy (LE), median years of schooling, and gross national income per capita for each survivor of the cohort of children treated during the year of the study.

In the methodology of the study, anonymized demographics and clinical data sets for every patient who underwent an operation by the William Novick Global Cardiac Alliance during calendar year 2015 in a LMIC were downloaded from the patient database kept by the charity. Patients were classified according to their diagnosis and surgical approach into 1 of the 6 component categories of

the Risk Adjusted Classification for Congenital Heart Surgery. Every patient operated on was included in the calculations of the costs of surgery, regardless of age, diagnosis, surgery, and outcome. Patients older than 16 years and those having an unspecified non cardiac operation (Risk Adjusted Classification for Congenital Heart Surgery non classifiable) were excluded from the cost-effectiveness and humanitarian footprint calculations. Every country where the charity teams were deployed to provide training and surgical patient care during 2015 was included.

Service costs (logistical and clinical) sustained by the charity during the 2015 surgical campaign were included in the calculation of the overall costs per surgery. Values included in the computations were extracted from tax forms and financial reports and are expressed in 2015 US dollars.

All service expenses directly related to the intervention, including staff salaries, traveling and housing expenses, gifts in kind, volunteers' time, donated equipment, medicines and disposables, costs of shipping the material from the central warehouse, reimbursements to staff and volunteers for excess luggage (hand-carried donations), and medical contracts (when staff or volunteers were not available) were included. Administration costs of running the charity (office space and administrative costs) were excluded. Staff salaries, medicines, disposables, and capital costs borne by the LMIC where the interventions took place were also excluded from the cost-effectiveness calculations.
According to this study, Over the last 20 years, child mortality around the world has decreased significantly, yet with nearly 1.3 million children born with CHD every year in areas with inadequate or absent services, disability and early deaths have, in relative terms, consistently increased. Congenital heart disease is among the top 10 causes of premature death in Latin America, Central Asia, Africa, and the Middle East, with nearly 250 000 neonates and infants lost every year owing to lack of early diagnosis and/or treatment. Birth defects in general, among which CHD accounts for at least 50%, will continue to be among the top 15 causes of the global burden of disease for the first quarter of the current century, and their management in underserved areas of the world is limited to the sparse efforts of local governments and home-grown or international

humanitarian organizations. The cost-effectiveness of paediatric cardiac surgery in LMICs has not been studied in detail before, but there is limited information available on the costs. Described within a range of $3000 to $10 000 per surgery, these costs are closer to the findings of this study and far from the common surgical charges at Western academic centers. A recent systematic review of the cost-effectiveness of essential surgical services in LMICs by Grimes et al, found a number of global basic surgical interventions (cataract surgery, male circumcision, emergency Caesarean delivery, and cleft palate surgery) to be as cost-effective as oral rehydration, promotion of breastfeeding, and antiretroviral therapy for HIV. These findings are corroborated by a contemporary review by Chao et al, with cost-effectiveness values as low as $13.78 per DALY for circumcision, $108.74 per DALY for hydrocephalus, $136 per DALY for ophthalmic surgery, and $82.32 per DALY for other common general surgical procedures. This study concluded that the humanitarian global interventions aimed at the establishment of paediatric cardiac surgery programs in LMICs are highly cost-effective and deserving of stronger international support. While cost-effectiveness constitutes a good metric for humanitarian interventions regarding contagious diseases, perhaps more encompassing measures, like our humanitarian footprint, should be considered when evaluating global surgical interventions.

A study, “Cost-effectiveness analysis in cardiac surgery: A review of its concepts and methodologies” by Ferket BS, et al, (2018) entails the following:
Cost-effectiveness analysis (CEA) in cardiac surgery continues to grow in relevance with increasing health care expenditures, a greater emphasis on value-based care, the continuing development of costly surgical and non-invasive technologies, advances in cardiac devices, and changes in eligibility criteria over the past two decades. Although the rapidly evolving surgical technologies pose challenges to CEA, improvements in gathering and leveraging long-term economic and clinical data alongside trials and in cardiac surgery registries represent future opportunities for the field. As such, it is important for cardiac surgeons to understand CEA with respect to existing and future surgical therapies. The study reviewed the fundamental principles of

cost-effectiveness analysis theory and discussed recent cost-effectiveness studies on cardiac surgery.

With most studies done across sub Saharan Africa focusing on paediatric populations, a study titled, “Cost and cost-effectiveness of cardiac surgery in elderly patients” by Sandro Gelsomino, et al , published in The Journal of Thoracic and Cardiovascular Surgery (November 2011) with an objective statement, “Cost-effectiveness of heart surgery for elderly patients is still poorly defined. We evaluated outcome, quality of life (QoL), cost, and cost-effectiveness of octogenarians undergoing cardiac surgery.” reviewed the following:

In the study methodology, one thousand six hundred forty octogenarians undergoing various cardiac surgical procedures were prospectively studied between January 1998 and January 2009 and compared with similar patients aged 70 to 79years. Several questionnaires were used to assess the Quality of Life (QoL). Six hundred age- and sex- matched healthy octogenarians and three hundred forty patients older than 80 years with medically treated valvular or coronary artery disease were healthy and unoperated control groups, respectively. In-hospital costs were obtained from the hospital’s financial accounting department and cost-effectiveness was estimated and expressed as cost/QoL-adjusted life year (QALY) and cost-effectiveness ratio.

Patients undergoing surgery were administered quality of life questionnaires preoperatively and at any follow-up appointments, along with clinical examination and echocardiographic control. Among survivors, seventy-six patients (4.3%) were not able to participate in the follow-up questionnaires. Reasons for non-participation included Alzheimer disease, other neurological problems, refusal, language barriers, data entry problems, terminal cancer and others .

Patients in the were routinely administered quality of life questionnaires after admission and then followed up on a regular basis by cardiologists and cardiac surgeons, undergoing quality of life assessment at a median of 9 months (range,

4–13 months) from first admission to the surgery waiting list. Subjects in another group were followed up by the general practitioners who enrolled them in the study. For these subjects, quality of life questionnaires were administered at randomly chosen times at general practitioner clinics or by phone. All interviews were carried out by 2 surgeons, both of whom were blinded to the aims of the study. The median time spent on interview was 28 minutes (interquartile range, 20–37 minutes).

Quality of life was measured with the Medical Outcomes Short Form 36-Item Health Survey (SF-36), which consists of 36 questions grouped into the following 8 multi-item domains: Physical, Functioning, Role Physical, Bodily Pain, General Health, Vitality, Social Functioning, Role Emotional, and Mental Health. Furthermore, SF-36also assesses 2 major health concepts, physical and mental, with 2 composite scores, the physical composite score (PCS) and the mental composite score (MCS). The physical scales (Physical Functioning, Role Physical, Bodily Pain, and General Health) make up the PCS, and the remaining four scales (Mental Health, Role Emotional, Vitality, and Social Functioning) make up the MCS. Reliability by the test–retest between baseline and at follow-up was good, with interclass correlation coefficients ranging between 0.73 and 0.86. Internal consistency was good for the 8 scales, with Cronbach coefficients ranging between 0.85 and 0.95. The Seattle Angina Questionnaire was only applied to those patients with coronary artery disease necessitating isolated coronary artery bypass grafting (CABG). It represents a reliable and validated instrument that measures five clinical dimensions of health in patients with coronary artery disease (physical limitation, anginal stability, anginal frequency, treatment satisfaction, and disease perception).

Zung's Self-Rating Depression Scale (SDS) was used to assess depression. The questionnaire consists of 20 questions,10 symptomatically positive and 10 symptomatically negative. Results were expressed as SDS raw score (sum of points for all 20 questions), SDS average score, and SDS index. The Italian version of the Spielberg State-Trait Anxiety Inventory form X1 was used to measure state anxiety (how one feels at a particular moment), whereas form

X2 was used to assess trait anxiety (how one usually feels). The scores range from 20 (very low anxiety) to 80 (very high Anxiety).

In-hospital costs were obtained from the hospitals' financial accounting departments. All billed items and their associated costs were assigned to one of the following 15 categories: preoperative (all costs before surgery), anaesthesia (costs of anaesthetics, equipment, and disposables used by anaesthesiologists), operative (costs related to the use of the operating rooms and all surgical equipment and disposables used by surgeons), perfusion (costs of cardiopulmonary bypass equipment, cardioplegia, and disposables used by perfusionists), intensive care unit (ICU, costs of nursing, equipment, and room in the cardiovascular ICU), postoperative room (costs related to nursing, equipment, and room in the step-down unit),respiratory therapy (costs related to respiratory equipment, treatments, and therapist time), laboratory (costs of blood tests), blood bank (costs related to blood typing and transfusion), cardiologic laboratory (cost of electrocardiograms, echocardiograms, and other non-invasive vascular studies), radiology (costs of radiographs, computed tomographic scans, and magnetic resonance scans), pharmacy (costs of drugs and dispensing), therapies (costs of physical, occupational, and speech therapy), supplies, and other costs. Postoperative costs were assigned to the following categories: physician visits, echocardiograms, anticoagulation therapy, rehospitalisation, reoperation, complications, pharmacy, specialties, home care facilities and other. They first calculated costs in the entire cardiac surgical population. Then operations were broken down into 6 categories: CABG, off-pump CABG, aortic valve replacement, mitral valve replacement, mitral valve repair, aortic surgery (including surgery of the ascending aorta or aortic arch, with or without a prosthetic valve), and associated CABG and valve surgery.

Costs were divided into the following categories; home and skilled nursing facilities, general medicine, pharmacy, hospitalization, specialties, therapies, diagnostics, and other. These costs were obtained directly from institutions' cost-accounting systems or from Health Ministry rates for services. Prices were

originally calculated in euros, converted to 2009 value with yearly inflation factors obtained from the consumer price index, and then changed to US dollars.

To calculate cost-effectiveness, the sum of lifetime costs was divided by the total quality-adjusted life years (QALYs) gained. The result was then divided by the number of patients. The lifetime total costs in the operative groups were obtained by summing; in-hospital costs, postoperative costs, and for subjects who are currently alive, estimated lifetime costs. Estimated survival after cardiac surgery was determined from the observed data from the follow-up system and completion of the currently censored lifetimes with a Gompertz regression model derived from the observed patient data. The simulation was repeated 1000 times, and the mean was used in the final calculation.

Estimated lifetime costs were assigned to the following categories: physician visits, echocardiograms, anticoagulation therapy, re-hospitalization, re-operation, complications, pharmacy, specialties, home care facilities, and other.

Data reflected resource acquisition costs, allocation of institutional cost, and indirect institutional costs derived from data obtained from Regional Health Care Administration Offices (Friuli Venezia Giulia, Toscana, Lombardia) or obtained from the service rates from the Italian Ministry of Health. To project the cost during these simulated future life years, physician visits and echocardiograms were assumed to occur annually. Hospitalization, rehospitalisation, and reoperation were obtained by applying the hazard function to observed data. Complications not related to time were assumed to occur at the same constant rates during the observed patient-years. QALYs were calculated on the basis of raw PCS and MCS. For both scores, each year in perfect health was assigned the value from 1 (maximum score 100) down to the value of 0.0 (minimum score 0), and values were added. For future simulated life years, PCS and MCS scores were linearly interpolated between the latest available raw scores and 0 (assumed for the end of life). The results of this study confirmed that cardiac procedures can be offered to octogenarians with acceptable morbidity and mortality, significant improvement in clinical

status, and satisfactory long-term results, comparable with those reported in the literature and are cost effective.

Empirical data on the cost-effectiveness of cardiac surgery in Zambia is sparse, reflecting broader gaps in healthcare infrastructure and economic evaluations. However, studies and reports underscore the growing burden of cardiovascular diseases and the urgent need for localized economic analyses.

Mulenga et al. (2020) assessed the economic feasibility of establishing a dedicated cardiac care unit in Zambia. Their findings indicated that upfront investment costs are high, but the unit could become cost-effective within five years, provided it reduces the need for patient referrals abroad. A government report by the Zambian Ministry of Health (2021) highlighted that most cardiac surgeries are performed outside Zambia, incurring significant financial burdens on patients and the healthcare system. This underscores the importance of cost-effectiveness studies to justify the establishment of local facilities. In a case study by Chanda et al. (2022), outcomes of foreign-funded cardiac surgery camps in Lusaka were analysed, showing that while these camps were effective in reducing patient mortality, their cost-effectiveness was contingent on external funding, which is not sustainable.

Zambia's healthcare financing is heavily reliant on government funding and international aid. The National Health Strategic Plan (2017-2021) prioritized the integration of specialized care, including cardiac surgery, into the public health framework (Ministry of Health, 2018). Limited studies have explicitly addressed the cost-effectiveness of cardiac surgery in Zambia. However, existing data, such as the distribution of ICERs across cardiac conditions (see Table 1), provides valuable insights. Negative ICERs observed in conditions like mitral stenosis and tricuspid regurgitation suggest that these surgeries are cost-effective within Zambia's economic context. The Zambian government has partnered with international organizations to enhance cardiac care. For example, the collaboration with Chain of Hope and the University Teaching Hospital (UTH) has facilitated subsidized surgeries. Mweene et al. (2020) found that these partnerships improved access by 40% while maintaining cost-

effectiveness. A very big gap in data exists as there is no known economic evaluation study done at the National Heart Hospital since its creation over three years ago.

Global and regional studies have employed various metrics, including ICERs, QALYs, and DALYs, to assess the value of cardiac surgeries. For instance, WHO's Choosing Interventions that are Cost-Effective (WHO-CHOICE) framework has been widely utilized. Techniques such as Markov models and decision tree analysis are prevalent. A study by Smith et al. (2021) used Markov modelling to evaluate the lifetime costs and benefits of CABG in different income settings, highlighting significant disparities. The WHO recommends using GDP per capita as a benchmark for cost-effectiveness. Studies in Zambia and similar LMICs often face challenges in meeting these thresholds due to resource constraints.

The reviewed studies collectively emphasize the cost-effectiveness of cardiac surgery under specific conditions: availability of local facilities, affordable consumables, and well-trained personnel. While global studies provide robust evidence, African and Zambian contexts highlight unique challenges, including but not limited to; Infrastructure gaps which limit access to specialized centers increases costs and reduces accessibility. Data scarcity which entails inconsistent data collection that hinders comprehensive cost-effectiveness analyses and lastly sustainability issues I.e over reliance on external funding poses risks to the continuity of care.

Despite these challenges, the studies agree on the potential for cardiac surgery to yield significant health and economic benefits if implemented efficiently. Future research in Zambia should focus on localized economic evaluations to inform policy and prioritize investments in cardiac care infrastructure.

2.1 Theoretical framework

The theoretical framework that guided this study drew upon several key concepts and frameworks from health economics, health policy, and health systems research. Specifically, this study is informed by the following theoretical perspectives:

- Cost-Effectiveness Analysis (CEA) and Cost-Utility Analysis (CUA): CEA and CUA are widely used methodologies in health economics for evaluating the economic efficiency of healthcare interventions. CEA compares the costs and outcomes of different interventions to determine which provides the most health benefits for a given cost, while CUA incorporates quality of life or utility measures to assess the value of healthcare interventions in terms of their impact on patients' well-being. These methodologies provide a systematic approach to assessing the cost-effectiveness and cost-utility of health expenditure on operative cardiac patients in Zambia.
- Access to Healthcare Services: The theoretical framework also considers the concept of access to healthcare services, which encompasses both physical access (availability and geographical proximity of services) and financial access (affordability of services). Assessing the cost-effectiveness and cost-utility of health expenditure on operative cardiac patients in Zambia has implications for improving access to essential cardiac interventions, particularly for underserved populations who may face barriers to accessing care. Healthcare Resource Allocation: The research is grounded in the principles of healthcare resource allocation, which seeks to optimize the allocation of limited resources to maximize health outcomes and achieve equitable access to healthcare services. By evaluating the cost-effectiveness and cost-utility of operative cardiac procedures, this study aims to inform resource allocation decisions within the Zambian healthcare system, ensuring that resources are allocated to interventions that provide the greatest health benefits for the population.
- Health Policy and Decision-Making: Finally, the research proposal is informed by theories of health policy and decision-making, which emphasize the importance of evidence-based policy-making and the use of

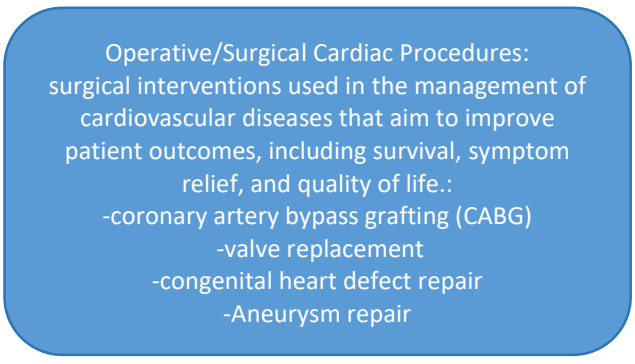
research evidence to inform healthcare decision-making processes. By generating robust evidence on the cost-effectiveness and cost-utility of cardiac interventions, this study aims to contribute to informed decision making among policymakers, healthcare providers, and other stakeholders involved in cardiac care delivery in Zambia.

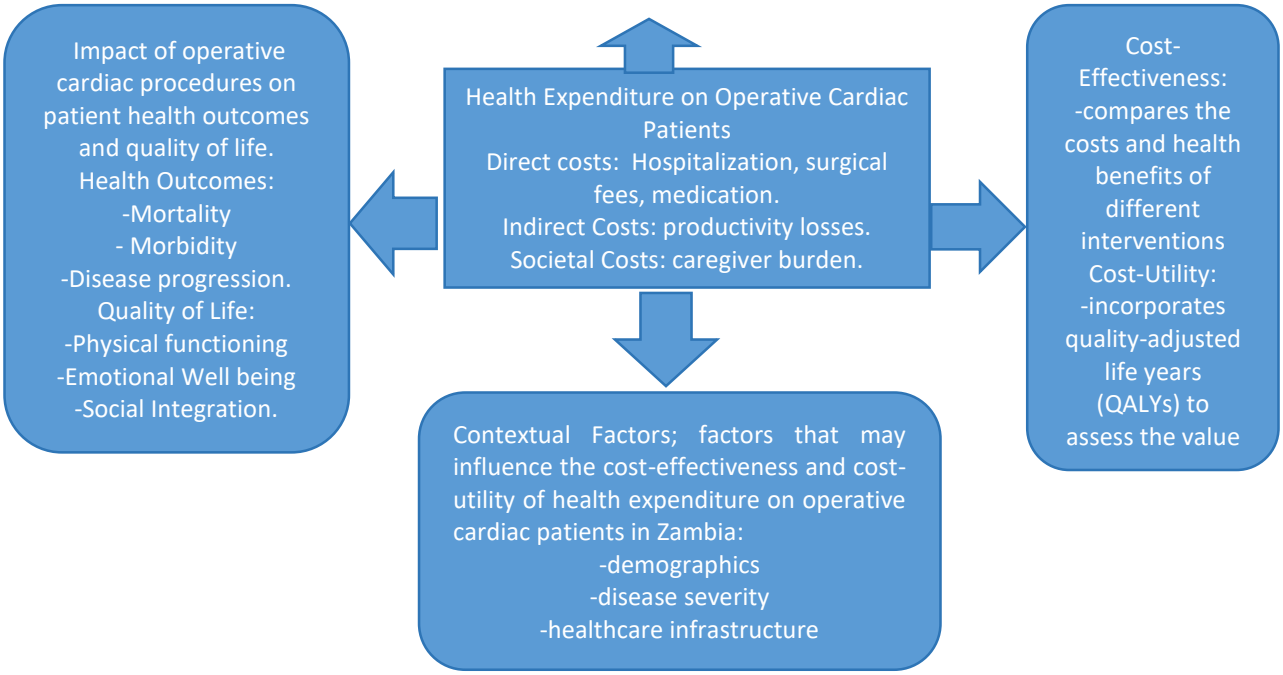
The theoretical framework outlined above provides a conceptual basis for this study on assessing (economic evaluation) the cost-effectiveness and cost-utility of health expenditure on operative cardiac patients in Zambia. By drawing upon key concepts and frameworks from health economics, health policy, and health systems research, this study aims to generate evidence that can inform resource allocation decisions, improve access to cardiac care services, and contribute to evidence-based policy making in Zambia's healthcare system.

2.2 Conceptual Framework

The conceptual framework guiding this study integrates key concepts and components relevant to assessing the cost-effectiveness and cost-utility of health expenditure on operative cardiac patients in Zambia. The framework delineates the interrelationships between various factors that influence the economic efficiency and health outcomes associated with cardiac interventions, providing a systematic approach to understanding the research objectives and outcomes. The conceptual framework below highlights how health expenditure on operative cardiac patients interacts with operative cardiac procedures, health outcomes, and contextual factors to influence the cost-effectiveness and cost-utility of cardiac interventions in Zambia.

Figure 1.0 : Conceptual Framework.





2.3 Gaps Identified in Literature

The gaps identified in the literature reviewed above include the following:

- Limited Research in Low-Middle Income Countries: While the cost-effectiveness and cost-utility of cardiac surgery is well-documented in high-income countries, there is a significant gap in low- and middle-income countries (LMICs), including Zambia, where healthcare systems are resource-constrained.
- Data Scarcity: In Zambia, there are no comprehensive studies on economic evaluation of cardiac surgery at the National Heart Hospital (NHH), despite its inception over three years ago. This gap limits the understanding of how resources are allocated and their impact on health outcomes.

Therefore, this study aimed at filling these gaps in literature.

CHAPTER THREE

Methodology

3.0 **Chapter Introduction**

This chapter outlines the methodological framework employed to assess the cost-effectiveness and cost-utility of health expenditure on cardiac surgery in Zambia. It describes the research approach and design, data collection methods, and analytical techniques used to evaluate the economic viability and health outcomes of cardiac surgical interventions within the Zambian healthcare context.

3.1 Research Approach:

This study followed a Quantitative research approach as it aims to provide measurable, objective data to assess the cost-effectiveness and cost-utility of healthcare interventions by measuring costs and outcomes.

3.2 Study Design

Retrospective Cohort Study: The study utilized existing data from medical records and hospital databases at the National Heart Hospital to assess the costs and outcomes of cardiac surgeries retrospectively. This design permitted for the examination of historical data to evaluate the cost-effectiveness and cost-utility of past surgical interventions. The study population included operative cardiac patients who had undergone surgical interventions for various cardiac conditions, with the inclusion criteria being all post-operative adult and paediatric cardiac patients and exclusion criteria being pre-operative and non-operative cardiac patients in all age groups. The time frame was from November 2024 to January 2025.

3.3 Study Population

The study population encompassed post cardiac surgery patients who are currently alive from 2022 to 2024.

3.4 Sample size:

The sample size was seventy (70) and was calculated using the Cochran formula shown below, with a 5% margin of error,95 % confidence level, and a population size of 100 with a response distribution of 50%.

$$n = \frac{Z^2 p(1-p)}{e^2}$$

Where:

n = sample size

Z = Z-score at 95% confidence level

p = the estimated proportion of an attribute that is present in the population.

e = margin of error or confidence interval.

3.5 Sampling Techniques.

The sampling technique that was employed in this study was the simple random sampling technique.

3.6 Data Collection Procedures

The data collection process was designed to gather comprehensive information on the costs, health outcomes, and quality of life associated with operative cardiac procedures at the National Heart Hospital in Zambia. The following steps were taken:

Data sources: These included hospital records from which data on patient demographics, clinical characteristics, surgical procedures, and costs were extracted from the hospital's electronic health records (EHR) and administrative databases; patient surveys through which post-operative patients or their caregivers were contacted via phone to complete the EQ-5D-5L health questionnaire, which measures quality of life before and after surgery and lastly departmental heads of the cardio-thoracic surgery department provided estimated costs for both surgical and non-surgical management of cardiac conditions.

Data collection tools included the EQ-5D-5L Questionnaire,a standardized tool used to assess patients' quality of life in five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each dimension has five levels of severity, ranging from "no problems" to "extreme problems." A structured form was used to collect cost data from hospital records and departmental heads. The form included estimates of categories such as; direct medical costs (e.g., surgical fees, hospitalization, medications, diagnostic tests),

indirect costs (e.g., productivity losses, caregiver burden) and Societal costs (e.g., long-term economic impact of improved health outcomes).

Data Collection Process: A list of post-operative cardiac patients treated at the National Heart Hospital between 2022 and 2024 was obtained from the hospital's records and relevant data on patient demographics, diagnoses, surgical procedures, and costs were extracted from the hospital's EHR and administrative database, patients or their caregivers were then contacted via phone to complete the EQ-5D-5L questionnaire. For patients who could not be reached (e.g., inactive phone numbers), their data were excluded from the analysis. Lastly, departmental heads provided estimated costs for both surgical and non-surgical management of cardiac conditions. These estimates were cross-verified with hospital records to ensure accuracy.

Ethical Considerations: Informed consent was obtained from all participants (patients or caregivers) before administering the EQ-5D-5L questionnaire. Patient confidentiality was maintained by anonymizing all data and ethical approval was obtained from the University of Lusaka and the National Health Research Authority.

3.7 Data Analysis

The data analysis process involved both cost analysis and effectiveness/utility analysis, using quantitative methods to evaluate the cost-effectiveness and cost-utility of operative cardiac interventions. The following steps were taken:.

Cost analysis: Data on estimated costs of surgical management and non-surgical/medical management of different cardiac diagnoses or conditions were extracted from hospital records and the heads of department of cardio-thoracic surgery. Costs were categorized and analyzed to estimate the financial burden associated with various cardiac interventions.

Effectiveness/Utility Analysis: QALYs were calculated using the EQ-5D-5L questionnaire. The questionnaire responses were converted into utility scores using country-specific value sets. QALYs were then calculated by multiplying the utility score by the survival time (in years) post-surgery.

Incremental Cost-Effectiveness Ratios (ICERs) and Incremental Cost-Utility Ratios (ICURs): ICERs were calculated by dividing the difference in costs between surgical and non-surgical interventions by the difference in health outcomes (e.g., lives saved, complications avoided). ICURs were calculated by dividing the difference in costs by the difference in QALYs gained. This provided a measure of the cost per QALY gained for each intervention. Positive, negative, and unknown ICER /ICURs distributions were analyzed across different diagnoses, highlighting variability in cost-effectiveness.

Statistical Techniques: Regression analysis, using SPSS, was employed to evaluate the relationship between cost inputs and clinical outcomes. Sensitivity analysis was conducted to assess the robustness of findings under various cost and outcome scenarios.

Data Visualization: The findings were presented using tables and figures, such as; Table 1.0: Percentages of ICERs per diagnosis/condition managed and deaths recorded, Figure 2.0: Distribution of ICERs by diagnosis and Table 3.0: Percentage distribution of patients based on ICER outcomes and mortality status.

3.8 **Ethical Consideration**

The study adhered to the ethical guidelines of the University of Lusaka and the National Health Research Authority. Key ethical considerations included:
Informed Consent: Patients or their caregivers provided informed consent before participating in the study.
Confidentiality: All patient data were anonymized to protect privacy.
Ethical Approval: The study received ethical approval from the relevant authorities.

3.9 **Validity and Reliability**

Ensuring the validity and reliability of the study findings was a critical focus. Key measures included:

Data Source Reliability: Data was sourced from verified administrative databases, hospital records, and registries, ensuring accuracy and consistency.
Inclusion and Exclusion Criteria: A defined inclusion criterion of post-operative adult and pediatric cardiac patients ensured that only relevant data was analyzed. Pre-operative and non-operative cases were excluded to maintain focus on the study objectives.
Sampling Technique: Simple random sampling minimized selection bias, and a sample size calculation using the Cochran formula ensured statistical adequacy.
Methodological Rigor: Standardized tools like the EQ-5D questionnaire were used to measure quality of life, ensuring comparability with global benchmarks. Statistical analyses adhered to established guidelines, including Drummond's principles for economic evaluation.
Triangulation: Multiple data sources, such as patient surveys, electronic health records, and clinical registries, were utilized to cross-verify findings.
Sensitivity Analysis: Variations in cost and outcome estimates were tested to ensure robustness under differing assumptions, enhancing the credibility of results.

Chapter Four.

Analysis and Presentation of Results.

4.0 Chapter Introduction

This chapter presents the findings and an in depth analysis of the results obtained from this study done at the National Heart Hospital in Lusaka, Zambia. The results are organized systematically to address the study objectives and research questions, with a focus on providing clear insights into the economic and health related implications of cardiac surgery interventions. It shows the calculated incremental cost effective ratio outcome for each cardiac condition managed and other outcomes (i,e death)elicited from the total sample size assessed.

The goal of this analysis is to provide policymakers and stakeholders with evidence-based recommendations for improving cardiac care delivery in Zambia while ensuring financial sustainability. This chapter, therefore, lays the groundwork for a nuanced understanding of the economic dynamics underpinning life-saving cardiac interventions.

4.1 Data Analysis Procedures

An appropriate statistical method to analyse the data was used, in this case, regression analysis, employing the tool, Statistical Package for Social Sciences (SPSS). Data analysis involved both cost analysis and effectiveness/utility analysis. In cost analysis, the direct and indirect costs associated with cardiac surgeries for the study population were obtained as ranges from hospital data bases through the heads of both adult and paediatric cardiac surgery to accurately estimate costs per intervention conducted. In effectiveness/ utility analysis, the effectiveness of cardiac surgeries and nonsurgical management of cardiac disease by analysing clinical outcomes (e.g., mortality rates, complications) and patient-reported outcomes (e.g., quality of life) were assessed and quality-adjusted life years (QALYs) gained were calculated using

data collected using preference-based measures, in this case, the EQ-5D health outcome questionnaire.
In addition, incremental cost-effectiveness ratios (ICERs) or incremental cost-utility ratios (ICURs) were calculated by comparing the additional costs incurred with the additional benefits gained from cardiac surgeries compared to alternative treatments (Drummond et al. (2015).

The findings were interpreted in the context of the study objectives and hypotheses and the implications of the results for healthcare policy and resource allocation decisions in Zambia discussed. The limitations of the study and areas for future research have also been highlighted. The findings of this study will be presented through peer-reviewed publications, conference presentations, presentations at the National Heart Hospital, or policy briefs to reach relevant stakeholders and contribute to the evidence base on cardiac care in Zambia. Below are the findings of the study.

4.2 Findings and Presentation of Data

Specific Objective 1: To evaluate the direct and indirect costs of operative cardiac procedures compared to non-surgical management:

The study found that the direct medical costs of operative cardiac procedures varied significantly depending on the complexity of the condition. For example, the average cost for mitral stenosis repair ranged between K100,000 and K200,000, including hospitalization, surgical fees, and medications, and the average cost for Aortic Dissection repair was significantly higher, ranging between K500,000 and K1,000,000, due to the need for specialized equipment and longer hospital stays.In contrast, the non-surgical management of cardiac conditions (e.g., medication and monitoring) was less costly, with average costs ranging between K50,000 and K100,000 per patient.

In the case of Indirect costs, patients undergoing surgery reported an average of 2-4 weeks of lost productivity due to hospitalization and recovery, compared

to 1-2 weeks for non-surgical management with caregivers of surgical patients reporting higher levels of stress and time commitment, particularly for complex procedures like aortic dissection repair.

With societal costs, The establishment of the National Heart Hospital has reduced referral costs for overseas treatment, saving an estimated K2,000,000 per patient in travel and accommodation expenses.

Successful surgeries, such as mitral stenosis repair, have enabled patients to return to work and contribute to the economy, highlighting the long-term societal benefits of investing in cardiac care.

Specific Objective 2: To assess the health outcomes and quality-adjusted life years (QALYs) gained from operative cardiac interventions.:

Health Outcomes:The study found that 2.86% of patients (2 out of 70) died post-operatively. Conditions with the highest mortality rates included Abdominal Aortic Aneurysm (100%) and Severe Pulmonary Stenosis with Noonan Syndrome (100%).

Quality-Adjusted Life Years (QALYs):Patients who underwent Mitral Stenosis repair reported an average gain of 10 QALYs, reflecting significant improvements in quality of life and physical functioning, with patients undergoing Sternal Cleft Repair showing an average gain of 12 QALYs, as the surgery had a life-changing impact on patients' ability to perform daily activities. Conditions like Atrial Septal Defect (ASD) and Ventricular Septal Defect (VSD) had unknown ICERS as QALYs could not be calculated due to insufficient follow-up data.

Specific Objective 3: To calculate incremental cost-effectiveness ratios (ICERs) and cost-utility ratios (ICURs) for operative cardiac interventions in Zambia:

Incremental Cost-Effectiveness Ratios (ICERs):The ICER was negative for Mitral Stenosis Repair, indicating that the intervention was cost-saving and highly effective. Aortic Dissection Repair on the other hand had an ICER which was positive, reflecting the high costs associated with this complex procedure.

Unknown ICERs for 61.43% of cases (43 out of 70) were recorded because ICERs could not be calculated due to incomplete data.
Incremental Cost-Utility Ratios (ICURs): The ICUR was negative per QALY gained for mitral stenosis repair and sternal cleft repair, indicating high cost-utility,whereas for conditions like Atrial Septal Defect and Ventricular Septal Defect, ICURs could not be calculated due to insufficient data on quality of life.

Tables and Figures.

Table 1.0 presents results on percentages of incremental cost effective ratios (ICERs) per diagnosis/condition managed and deaths recorded. The study has shown that certain conditions, such as Mitral Stenosis, Tricuspid Regurgitation, Sternal Cleft, and Pericarditis, exclusively exhibit negative ICERs (100%). This implies that interventions for these conditions are highly cost-effective, delivering significant health benefits relative to their costs.

Conditions like Atrial Septal Defect (ASD) and Ventricular Septal Defect (VSD) show a mix of ICER outcomes: For ASD, 42% of cases have negative ICERs, while 58% remain unknown. For VSD, 43% of cases have negative ICERs, 7% positive, and 50% unknown. This variability suggests that while these interventions may be beneficial in some cases, data gaps or methodological limitations hinder comprehensive evaluation.

Several conditions, including Left Atrial Mass, Mediastinal Mass, Myxoma, and Severe Mitral Regurgitation, have 100% unknown ICERs. This was due to the unavailability of correct patient contact details in the hospital records and some contact numbers for post-operative patients not being active.

Conditions such as Abdominal Aortic Aneurysm (AAA) and Severe Pulmonary Stenosis with Noonan Syndrome report 100% mortality. This indicates extremely poor outcomes for these patients, potentially due to delays in intervention, the severity of disease, or resource constraints.

Other conditions like Aortic Dissection exhibit both negative ICERs (67%) and a significant mortality rate (16%), suggesting variability in treatment outcomes.

Table 1.0: Percentages of Incremental cost effective ratios (ICERs) per diagnosis/condition Managed and Deaths recorded.

Diagnosis/Condition	% Negative ICER	% Positive ICER	% Unknown ICER	% DEAD
Abdominal Aortic Aneurysm	0	0	0	100
Aortic Dissection	67	0	17	16
Atrial Septal Defect	42	0	58	0
Left Atrial Mass	0	0	100	0
Mediastinal Mass	0	0	100	0
Mitral Regurgitation	50	0	50	0
Mitral Stenosis	100	0	0	0
Tricuspid Regurgitation	100	0	0	0
Myxoma	0	0	100	0
Patent Ductus Arteriosus	25	0	75	0
Severe Mitral Regurgitation	0	0	100	0
Severe Mitral Stenosis	25	0	75	0
Severe Pulmonary stenosis with Noonans Syndrome	0	0	0	100
Sternal Cleft	100	0	0	0
Pericarditis	100	0	0	0
Thrombus	0	33	67	0
Tetralogy of Fallot	20		80	0
Ventricular Septal Defect	43	7	50	0

Figure 2.0: Distribution of Incremental Cost Effective Ratios (ICERs) by Diagnosis.

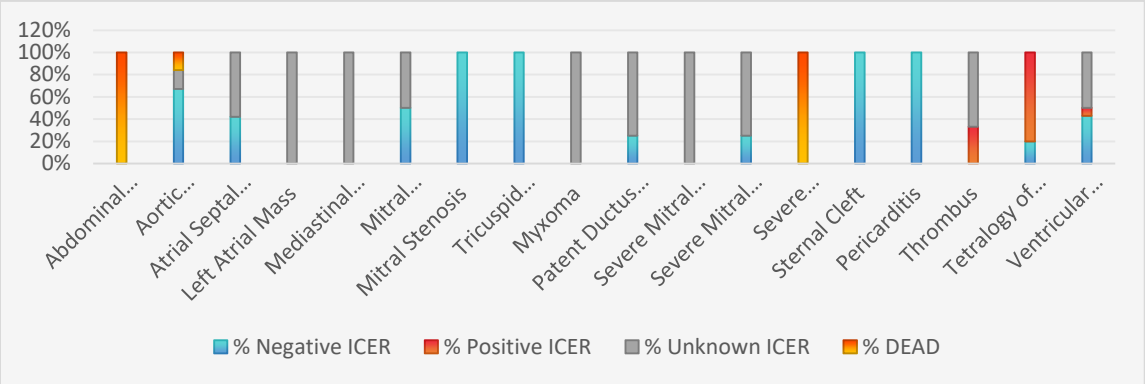


Figure 2.0 visually presents the proportion of negative, positive, and unknown ICERs for different cardiac diagnoses managed at Zambia's National Heart Hospital.

A negative ICER suggests that the intervention is highly cost-effective, as it provides significant health benefits for a relatively low cost or even cost savings. Positive ICERs were less common in this study and indicate interventions that provide health benefits but at a higher cost. Unknown ICERs were due to insufficient data to determine the relationship between cost and utility and lastly, while not directly part of ICERs, mortality outcomes like 100% deaths for severe pulmonary stenosis with Noonan's syndrome highlight conditions with poor survival rates despite interventions.

Table 2.0 below presents the classification of patients based on their Incremental Cost-Effectiveness Ratio (ICER) outcomes and mortality status:

Negative ICERs (23 patients): A negative ICER indicates that the surgical intervention not only improved patient outcomes but also reduced costs compared to the alternative or baseline. Twenty three cases of the total sample size of seventy (70) represent cost-effective interventions where the health benefits significantly outweighed the costs.

Positive ICERs (2 patients): Positive ICERs suggest that the interventions were effective but incurred higher costs compared to alternative approaches.

Whether this is considered cost-effective depends on the willingness-to-pay threshold. In this case, two patients out of the total sample size of seventy (70) had positive incremental cost effective ratios.

Unknown ICERs (43 patients): A majority of patients fall into the "unknown ICER" category, highlighting data gaps or challenges in determining the cost-effectiveness of interventions for these cases. This reflects the need for improved data collection and analysis to comprehensively evaluate outcomes. The forty three patients either had wrong contact details recorded or their contact numbers were all together unreachable.

Deaths : A small number (two) of patients succumbed post-operatively. This could signal critical areas for improving surgical or postoperative care.

Table 2.0: Distribution of Patients Based on ICER Outcomes and Mortality Status.

Number of Patients with negative ICERs	Number of patients with positive ICERs	Number of patients with unknown ICERs	Number of dead patients.
23	2	43	2

Table 3.0 shows the percentage distribution of patients based on their ICER outcomes and mortality status, the table entails the following:
Negative ICERs (32.86 %): For 32.86% of the study population, the cardiac interventions provided more benefit relative to their costs, which is an encouraging outcome for policymakers.
Positive ICERs (2.86%): This small fraction (2.86%) suggests a limited number of cases where the interventions might not have been optimally efficient.
Unknown ICERs (61.43%): With 61.43% of cases falling into this category, the study underscores a significant data gap that could hinder definitive conclusions on the cost-effectiveness of many interventions.
Mortality Outcomes (2.86%): While the mortality rate appears low (2.86%), further analysis of these cases could help improve clinical outcomes.

Table 3.0: Percentage Distribution of Patients Based on ICER Outcomes and Mortality Status

ICER Outcomes	Number of Patients	Percentage (%)
Negative ICERs	23	32.86
Positive ICERs	2	2.86
Unkown ICERs	43	61.43
Deaths	2	2.86

Figure 3.0: Percentage Distribution of Incremental Cost-Effective Ratios (ICERs) of Patients per Diagnosis Managed.

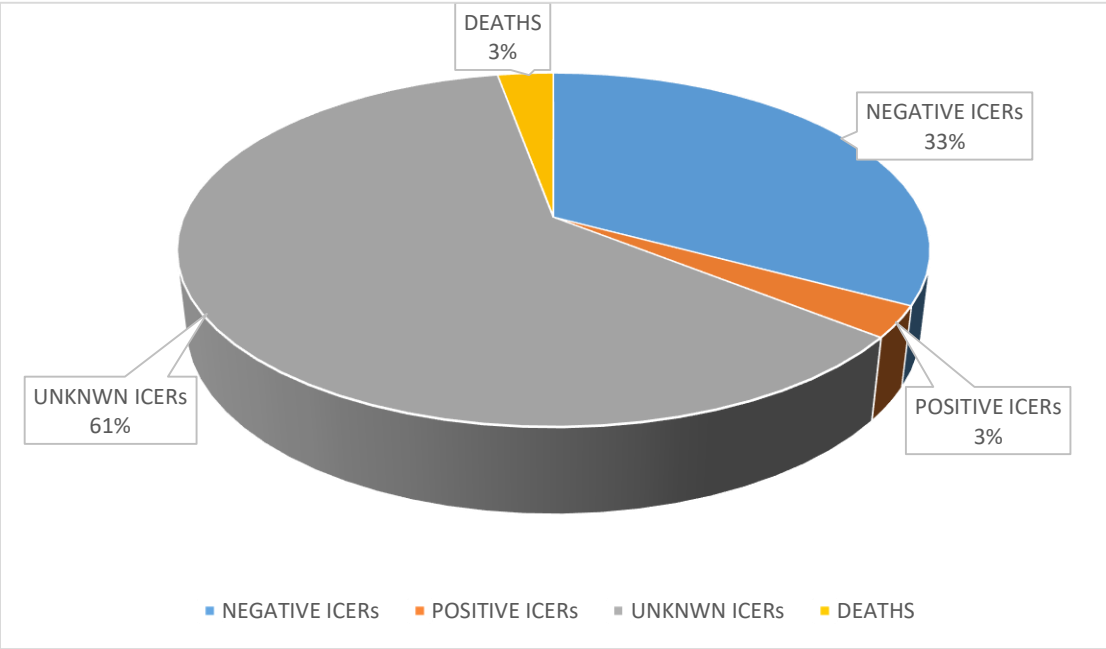


Figure 3.0 presents the percentage distribution of Incremental Cost-Effective Ratios (ICERs) of patients per diagnosis managed. The figure illustrates the following:

Negative ICERs (%): These indicate conditions where the interventions were cost-effective, meaning the cost incurred for the treatment was justified by the

significant health benefits achieved. Diagnoses such as mitral stenosis and sternal cleft dominate this category based on earlier tables.

Positive ICERs: A low percentage of cases falls here, signifying that interventions were less cost-effective or potentially costly relative to the benefits. For instance, conditions such as thrombus had a limited but notable positive ICER presence.

Unknown ICERs: This category, which forms a significant portion of the data, suggests gaps in the data collection or analysis for certain conditions. Diagnoses like atrial septal defect and ventricular septal defect contributed heavily to this group, highlighting challenges in incurred assessing cost-utility.

Deaths (ICER not applicable): A small percentage (e.g abdominal aortic aneurysm) reflects mortality where ICERs could not be meaningfully calculated due to the outcome.

Chapter Five

Discussion of Findings.

5.0 Chapter Introduction

This chapter discusses the broader implications of the study findings and compares them with similar research conducted globally and regionally. The discussion focuses on the economic, clinical, and policy implications of the findings, highlighting how they contribute to the existing body of knowledge on cost-effectiveness and cost-utility in cardiac care, particularly in low- and middle-income countries (LMICs) like Zambia.

5.1 Economic Implications

The study's findings on the cost-effectiveness and cost-utility of operative cardiac interventions in Zambia have significant economic implications, particularly in the context of limited healthcare resources as discussed below:

Cost-Effective Interventions: The study identified several interventions, such as mitral stenosis repair and sternal cleft repair, as highly cost-effective, with negative ICERs and low ICURs. These findings align with global studies, such as those by Neumann et al. (2017), which found that cardiac surgeries like coronary artery bypass grafting (CABG) were cost-effective in high-income countries. However, the study adds to the literature by demonstrating that similar cost-effectiveness can be achieved in resource-constrained settings like Zambia, provided that investments are made in local infrastructure and workforce training.

High-Cost Interventions: For complex procedures like aortic dissection repair, the study found positive ICERs, reflecting the high costs associated with these interventions. This is consistent with findings from Kolh et al. (2021), who noted that high-risk cardiac surgeries often have higher costs but can still be justified

by the significant health benefits they provide. The study highlights the need for targeted financing strategies to ensure that such interventions remain accessible to patients in LMICs.

Unknown ICERs and Data Gaps: The high proportion of unknown ICERs (61.43%) underscores the challenges of conducting economic evaluations in settings with limited data. This finding echoes the work of Rusingiza et al. (2019), who highlighted the difficulties of collecting comprehensive cost and outcome data in LMICs. The study emphasizes the importance of improving data collection systems to enable more robust economic evaluations in the future.

5.2 Clinical Implications.

The study's findings on health outcomes and quality-adjusted life years (QALYs) have important clinical implications for cardiac care in Zambia as discussed below:

Improved Quality of Life: The study found that interventions like mitral stenosis repair and sternal cleft repair resulted in significant gains in QALYs, reflecting improvements in patients' physical functioning, emotional well-being, and social integration. These findings are consistent with studies by McMurray et al. (2019), which demonstrated that cardiac surgeries can significantly enhance patients' quality of life, even in resource-limited settings.

High Mortality Rates for Certain Conditions: The study identified conditions like abdominal aortic aneurysm and severe pulmonary stenosis with Noonan syndrome as having 100% mortality rates, despite surgical intervention. This highlights the need for early diagnosis and timely intervention to improve outcomes for patients with advanced or complex cardiac conditions. Similar findings were reported by Mlambi et al. (2023), who noted that late presentation and limited access to specialized care are major barriers to improving survival rates in LMICs.

Data Gaps and Follow-Up Challenges:The inability to calculate QALYs for conditions like atrial septal defect (ASD) and ventricular septal defect (VSD) due to insufficient follow-up data underscores the need for better patient tracking systems. This aligns with the work of Awuah et al. (2023), who called for improved data collection and monitoring in African cardiac care programs.

5.3 Policy Implications

The study's findings have important implications for healthcare policy and resource allocation in Zambia and other LMICs, which include the following:

Prioritization of Cost-Effective Interventions: The study recommends prioritizing interventions with negative ICERs, such as mitral stenosis repair, as they provide significant health benefits at a lower cost. This aligns with the World Health Organization's (WHO) recommendation to focus on cost-effective interventions to achieve universal health coverage (UHC). Similar recommendations were made by Vos et al. (2020), who emphasized the importance of cost-effective policies in reducing the global burden of non-communicable diseases.

Investment in Local Capacity: The study highlights the need for investment in local healthcare infrastructure and workforce training to reduce reliance on international partnerships and improve the sustainability of cardiac care programs. This is consistent with findings from Mulenga et al. (2020), who argued that upfront investments in local facilities can yield long-term cost savings and improve access to care.

Community Engagement and Awareness: The study underscores the importance of public health campaigns to educate communities about the benefits of early diagnosis and treatment of cardiac conditions. This aligns with the work of Chabwela Shumba et al. (2023), who highlighted the role of community engagement in improving access to cardiac care in Zambia.

5.4 Comparison with Global and Regional Studies

The study's findings are consistent with global and regional research on the cost-effectiveness and cost-utility of cardiac care, but they also highlight unique challenges faced by LMICs like Zambia as highlighted below:

Global Comparisons: The study's findings on the cost-effectiveness of mitral stenosis repair and sternal cleft repair are consistent with global studies, such as those by Neumann et al. (2017) and Kolh et al. (2021), which found that cardiac surgeries can be cost-effective even in high-income countries. However, the study adds to the literature by demonstrating that similar outcomes can be achieved in LMICs with targeted investments.

Regional Comparisons: The study's findings on the challenges of data collection and follow-up align with regional studies, such as those by Rusingiza et al. (2019) and Mlambi et al. (2023), which highlighted the difficulties of conducting economic evaluations in African settings. The study contributes to the regional literature by providing a detailed analysis of the cost-effectiveness and cost-utility of cardiac care in Zambia.

5.5 Limitations of the Study

The study, while providing valuable insights into the cost-effectiveness and cost-utility of health expenditure on operative cardiac patients in Zambia, has several limitations that may influence the interpretation and applicability of its findings. These include the following:

- Sample Size and Representation: The sample size of 70 patients, although calculated to ensure statistical significance, may not comprehensively represent the diverse range of cardiac conditions managed within the Zambian healthcare system. This limits the generalizability of the findings to the broader population.
- Sample Size and Representation: The sample size of 70 patients, although calculated to ensure statistical significance, may not comprehensively represent the diverse range of cardiac conditions managed at the National Heart Hospital. This limits the generalizability of the findings to the broader population.

- Contextual Limitations: The study is confined to a single healthcare facility, the National Heart Hospital in Lusaka, Zambia. Therefore, the findings may not fully capture variations in healthcare access, infrastructure, and patient outcomes across other regions of the country.
- Economic and Societal Costs: While the study evaluates direct medical costs, indirect societal costs, such as long-term productivity losses and caregiver burden, may not have been fully accounted for, potentially underestimating the true economic impact.
- Retrospective Design: The reliance on retrospective data limits the ability to control for confounding variables that may influence outcomes. Additionally, the absence of real-time data collection might have affected the accuracy of cost and utility estimations.

Chapter Six

Conclusions and Recommendations.

6.0 Chapter Introduction.

This final chapter synthesizes the key findings of the economic evaluation of cardiac surgery in Zambia, providing a comprehensive summary of the study objectives, methodology, and results. It summarizes key insights from the

analysis of the cost-effectiveness, accessibility, and sustainability of cardiac surgical interventions in the Zambian health system. Based on these findings, this chapter provides practical recommendations relevant to policy makers, health care providers, and stakeholders to improve resource allocation, expand access, and optimize the economic viability of cardiac surgery services in Zambia. These recommendations aim to address the gaps identified in the study, ensuring effective delivery of critical care while promoting the long-term resilience of the health system.

6.1 **Conclusions.**

The study on the cost-effectiveness and cost utility of health expenditure for cardiac surgery in Zambia highlights critical insights into the allocation of healthcare resources and the outcomes of such investments.

By the measured distribution of ICERs; a significant portion of patients (61.43%) fell into the "unknown ICER" category, indicating a lack of sufficient data to fully assess cost-effectiveness. 32.86% of patients had negative ICERs, suggesting cost-effectiveness in these cases and only 2.86% had positive ICERs, reflecting high costs relative to health benefits, which might necessitate alternative approaches to care.

The condition-specific analysis revealed that several conditions, such as mitral stenosis, tricuspid regurgitation, and pericarditis, had exclusively negative ICERs, indicating favourable cost-effectiveness for intervention. On the other hand, conditions like myxoma, severe mitral regurgitation, and severe mitral stenosis had all cases categorized under unknown ICERs, emphasizing data gaps for these specific conditions. Conditions like tetralogy of Fallot and ventricular septal defect presented a mix of outcomes, warranting further exploration. The low mortality rate (2.86%) suggests reasonable survival outcomes, albeit with limited data to fully contextualize these results in relation to the cost-effectiveness framework. A significant proportion of the conditions (e.g., sternal cleft, mediastinal mass) with exclusively negative ICERs indicate potential areas for prioritizing health financing to achieve high returns on investment in terms of patient outcomes.

With continuous government support and funding to the various surgical interventions currently being conducted at the National Heart Hospital by both indigenous paediatric and adult cardio thoracic surgeons and their supporting staff, the trajectory cardiac surgery in Zambia is showing promising country, regional and global success. The returns on investment are sure to be recovered through human capital.

6.2 **Recommendations.**

The results obtained and analysed show the positive impact cardiac surgery is bringing to the economy as a number of post-operative patients are doing well and contributing to the economy through the various activities they are effectively conducting, for instance, going back to school and work thereby securing the future and economic gains of the country as a healthy workforce entails good economic outputs. The following are the recommendations that can be considered by both the government through the ministry of health and the local hospital itself I.e the National Heart Hospital.

- Enhanced Data Collection and Analysis: Investment in robust data collection frameworks is needed to reduce the proportion of "unknown ICERs." This can involve standardized reporting protocols and improved tracking systems with enhanced training and close monitoring of hospital stuff working under the monitoring and evaluation department as they are the sore custodians of patient records at the National Heart Hospital. Enhanced data collection and analysis is very vital as it affected the results of the study due to the predominant non-availability of functional patient or caregiver contact details.
- Prioritization of Cost-Effective Interventions: The ministry of health and the local hospital budget should allocate more resources preferentially toward conditions with consistently negative ICERs, such as mitral stenosis and pericarditis, to maximize health benefits per dollar or kwacha spent. This will ensure a certain return on investments for the interventions funded. In addition to this, targeted financing strategies must be developed for conditions with mixed or unknown ICERs to clarify their cost utility.

- Policy Integration: Incorporate the findings into national health financing strategies to better align with the Sustainable Development Goals (SDG) for health, particularly universal health coverage and equitable access to surgical care.
- Capacity Building: Of great importance is strengthening of the local healthcare systems to address conditions with high treatment costs and positive ICERs, either through technological innovation, training, or partnerships to reduce costs.
- Community Engagement and Awareness: Public health programs and engagements to educate communities about cost-effective cardiac care options to enhance utilization of available resources at the Hospital.
- Further Research: research always attempt to answer questions and its importance cannot be over emphasized. There is need to conduct longitudinal studies to assess the long-term cost utility of cardiac surgery in Zambia, incorporating quality-adjusted life years (QALYs) and disability-adjusted life years (DALYs) metrics.

These steps can help refine health financing frameworks, improving access to and the quality of cardiac surgical care while ensuring efficient use of limited resources in Zambia.

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Appendices

Appendix A: Research Questionnaire.

My name is Eric Chisenga, a Master of Business Administration in Healthcare management(MBAHCM) student at the University of Lusaka. I am conducting research titled “Assessing the Cost-Effectiveness and Cost-Utility of Health Expenditure on Operative Cardiac Patients in Zambia”

This questionnaire aims to gather information on the estimated costs of the different cardiac surgical interventions performed and also estimated costs of

medical management of the same cardiac conditions on which surgery was performed and patients health outcomes. Your participation is voluntary, and all responses will be kept confidential and used solely for academic purposes.

Section A: Patient Demographics.

What is your age group?

I.Peadiatric

II.Adult

What is your gender?

I.Male

II.Female

What is your primary residence?

I.Urban

II.Rural

What is your level of education?

I.No formal education

II.Primary education

III.Secondary education

IV.Tertiary education

Section B: Medical Information

Are you a cardiac surgery patient or a caregiver for one?

I.Patient

II.Caregiver

What type of cardiac surgery was performed?

Specify……..

Section C: Cost-Effectiveness :Hospital Management/Departmental Head.

What is the estimated cost (direct costs) of the surgical management of the above procedure?

1.Less than K50,000

2.K50,000–K100,000

3.K100,001–K500,000

4.Above K500,000

What is the estimated cost(direct) of non-surgical/medical management of the same condition?

1. Less than K50,000
2. K50,000–K100,000
3..K100,001–K500,000
4. K500,000- K1,000,000

Section D: Cost Utility

Post-Operative: EQ-5D-5L Health Questionnaire: Under each heading, please tick the ONE LEVEL that best describes your health today

Mobility

□Level 1: I have no problems walking.
□Level 2: I have slight problems walking.
□Level 3: I have moderate problems walking.
□Level 4: I have severe problems walking.
□Level 5: I am unable to walk.

Self-Care

□Level 1: I have no problems washing or dressing myself.
□Level 2: I have slight problems washing or dressing myself.
□Level 3: I have moderate problems washing or dressing myself.
□Level 4: I have severe problems washing or dressing myself.
□Level 5: I am unable to wash or dress myself.

Usual Activities (e.g., work, study, housework, family, or leisure activities)

□Level 1: I have no problems doing my usual activities or doing my work.
□Level 2: I have slight problems doing my usual activities.
□Level 3: I have moderate problems doing my usual activities.
□Level 4: I have severe problems doing my usual activities.
□Level 5: I am unable to do my usual activities.

Pain/Discomfort

□Level 1: I have no pain or discomfort.
□Level 2: I have slight pain or discomfort.

□Level 3: I have moderate pain or discomfort.

□Level 4: I have severe pain or discomfort.

□Level 5: I have extreme pain or discomfort.

Anxiety/Depression

□Level 1: I am not anxious or depressed.

□Level 2: I am slightly anxious or depressed.

□Level 3: I am moderately anxious or depressed.

□Level 4: I am severely anxious or depressed.

□Level 5: I am extremely anxious or depressed.

Pre-operative: EQ-5D-5L Health Questionnaire: Under each heading, please tick the ONE LEVEL that best describes your health before the operation.

Mobility

□Level 1: I had no problems walking.

□Level 2: I had slight problems walking.

□Level 3: I had moderate problems walking.

□Level 4: I had severe problems walking.

□Level 5: I was unable to walk.

Self-Care

□Level 1: I had no problems washing or dressing myself.

□Level 2: I had slight problems washing or dressing myself.

□Level 3: I had moderate problems washing or dressing myself.

□Level 4: I had severe problems washing or dressing myself.

□Level 5: I was unable to wash or dress myself.

Usual Activities (e.g., work, study, housework, family, or leisure activities)

□Level 1: I had no problems doing my usual activities or doing my work.

□Level 2: I had slight problems doing my usual activities.

□Level 3: I had moderate problems doing my usual activities.

□Level 4: I had severe problems doing my usual activities.

□Level 5: I was unable to do my usual activities.

Pain/Discomfort

□Level 1: I had no pain or discomfort.

□Level 2: I had slight pain or discomfort.

□Level 3: I had moderate pain or discomfort.

□Level 4: I had severe pain or discomfort.

□Level 5: I had extreme pain or discomfort.

Anxiety/Depression

□Level 1: I was not anxious or depressed.

□Level 2: I was slightly anxious or depressed.

□Level 3: I was moderately anxious or depressed.

□Level 4: I was severely anxious or depressed.

□Level 5: I was extremely anxious or depressed.

Appendix B: National Health Research Authority Certificate

NATIONAL HEALTH RESEARCH AUTHORITY

The Health Research Act (Act No. 2 of 2013)

MINISTRY OF HEALTH

CERTIFICATE OF REGISTRATION

THIS IS TO CERTIFY THAT

Eric Chisenga

has been registered as a Health Researcher

Dated this 7th December 2024

Registration number NHRAR-R-2221/28/11/2024

A/DIRECTOR AND CHIEF EXECUTIVE OFFICER PROF. VICTOR CHALWE

Appendix B: Permit to Conduct Research at NHH

All communications should be addressed
to the Senior Medical Superintendent
Telephone: +260 211 410069/+260 211 410070

In reply please quote:
No. NHH/101/1/13

Republic Of Zambia

MINISTRY OF HEALTH

NATIONAL HEART HOSPITAL
P.O.Box 36458
LUSAKA

10th December, 2024

Eric Chisenga
University of Lusaka
Alick Nkhata Mass Media
P.O Box 36711
LUSAKA

Dear Dr. Chisenga

RE: PERMISSION TO CONDUCT RESEARCH AT NATIONAL HEART HOSPITAL

Reference is made to your letter dated 19th November, 2024 in which you requested for permission to conduct a research study on **"Assessing the cost-effectiveness and cost-utility of health expenditure on operative Cardiac patient in Zambia"**

I am pleased to inform you that your request has been approved. The area of interest has been well noted.

Best wishes as you conduct your research.

Dr. Chabwela Shumba
Senior Medical Superintendent
National Heart Hospital

C.c Chair of Research Unit