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THE MICROBIOLOGICAL PROFILES AND OUTCOMES OF PEDIATRIC ORTHOPEDIC INFECTIONS AT HIWOT FANA COMPREHENSIVE SPECIALIZED UNIVERSITY HOSPITAL, HARAR, ETHIOPIA

THESIS REPORT

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Pediatric Orthopedics Infections: The Microbiological Profile, Treatment outcome and Factors Determining Outcome in Hiwot Fana Comprehensive Specialized University Hospital, Harar, Ethiopia

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I hereby certify that I have read and evaluated this thesis entitled **"Pediatric Orthopedics Infections: Microbiological Profile, treatment outcome and Factors Determining Outcome in Hiwot Fana Comprehensive Specialized University Hospital, Harar, Ethiopia":** prepared under my guidance by Tesfahun Kebede (MD). I recommend that it can be submitted as fulfilling the thesis requirement.

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STATEMENT OF THE AUTHOR

I, the undersigned, solemnly declare and affirm that this thesis is the result of my own work. In its preparation, I have faithfully observed all ethical and scholarly principles, including the processes of data collection, analysis, and compilation. Any academic material incorporated herein has been duly acknowledged through proper citation.

This thesis is submitted in partial fulfilment of the requirements for the Postgraduate Program in Orthopaedics and Trauma Surgery at Haramaya University. It will be deposited in the Haramaya University Library and made accessible to borrowers in accordance with the Library's regulations. I further affirm that this thesis has not been submitted to any other institution for the award of a degree, diploma, or certificate.

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BIOGRAPHICAL SKETCH

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ACROYMS AND ABBREVIATIONS

AOR	Adjusted Odd`s Ratio
CHMS	College of Health and Medical Science
CI	Confidence Interval
COR	Crude Odds Ratio
DC	Data Collector
DM	Diabetes Mellitus
DVT	Deep Vein Thrombosis
EPHI	Ethiopian Public Health Institution
FMOH	Federal Ministry of Health
GBD	Global Burden of Disease
HCP	Health Care Provider
HFCSUH	Hiwot Fana Comprehensive Specialized University Hospital
HIV	Human Immunodeficiency Virus
HMIS	Health Management Information System
IHRERC	Institutional Health Research Ethical Review Committee
IQR	Inter-Quartile Range
LMICs	Low- and Middle- Income Countries
MIC	Minimum Inhibitory Concentration
MRSA	Methicillin-Resistant Staphylococcus Aureus
MSK	Musculoskeletal
MSSA	Methicillin-Sensitive Staphylococcus Aureus
NICU	Neonatal Intensive Care Unit
PCR	Polymerase Chain Reaction
PI	Principal Investigator
SD	Standard Deviation
SPSS	Statistical Package for the Social Sciences
TB	Tuberculosis
OAI	Osteo-Articular Infection
ODK	Open Data Kit
YLD	Years Lived with a Disability
WHO	World Health Organization

ABSTRACT

Background: Pediatric orthopedic infections are a significant cause of morbidity in low-income countries, yet data from Eastern Ethiopia are limited.

Objectives: To assess the microbiological spectrum, clinical outcomes, and determinants of outcome in pediatric orthopedic infections at Hiwot Fana Comprehensive Specialized University Hospital, Harar, Ethiopia.

Methods: A retrospective cross-sectional review was conducted on medical records of 311 pediatric patients (≤18 years) diagnosed with orthopedic infections between January 2022 and December 2024. Data were collected using a structured checklist and analyzed with SPSS version 27. Bivariate and multivariable logistic regression analyses were performed to identify predictors of poor treatment outcomes, with statistical significance set at $p<0.05$

Results: Orthopedic infections accounted for 32.0% of pediatric orthopedic consultations. The mean age was 11.2 years (SD=4.86), with a predominance of males (72.0%) and rural residents (71.7%). Chronic osteomyelitis was the most common diagnosis (29.3%), followed by septic arthritis (16.4%) and acute osteomyelitis (10.6%). Cultures were positive in 58.0% of cases with Staphylococcus aureus as the predominant pathogen (45.1%). Notably, 72.3% of Staphylococcus aureus isolates were methicillin-resistant (MRSA). Resistance to commonly used antibiotics was high: ceftriaxone (69.2% resistant), ampicillin (81.5%), while Vancomycin (>90%), clindamycin (83.1%), and gentamicin (81.5%) retained good activity. Combined surgical and medical therapy was used in 97.1% of patients, but only 41.5% received culture-guided definitive antibiotics. Median time to emergency surgery was 8 hours, with 72.0% experiencing delay >6 hours. Complete recovery without complications was achieved in 60.8%, while 15.8% had complicated/unresolved infections, and mortality was 0.6%. Multivariable analysis identified late presentation >7 days (AOR=2.41; 95% CI: 1.24-4.67), multifocal involvement (AOR=2.70; 95% CI: 1.33-5.50), prior antibiotic exposure (AOR=2.75; 95% CI: 1.54-4.90), malnutrition (AOR=2.45; 95% CI: 1.26-4.79), MRSA infection (AOR=3.27; 95% CI: 1.56-6.85), and delay in emergency surgery >6 hours (AOR=1.82; 95% CI: 1.01-3.25) as independent predictors of poor outcome.

Conclusion: Pediatric orthopedic infections at HFCSUH are characterized by high prevalence, advanced disease at presentation, alarming antimicrobial resistance (particularly MRSA at 72.3%), and suboptimal outcomes. Current empirical therapy (ceftriaxone-based) is inadequate. Delayed presentation, malnutrition, MRSA, and surgical delays independently predict poor outcomes. Updated local treatment guidelines, strengthened diagnostic capacity, and improved surgical access are urgently needed.

Keywords: Pediatric orthopedic infections, osteomyelitis, septic arthritis, MRSA, antimicrobial resistance, treatment outcome, Ethiopia

1. INTRODUCTION

1.1. Background

Pediatric orthopedic infections, such as osteomyelitis, septic arthritis, and soft tissue infections, represent a significant clinical challenge due to their potential for causing severe and lasting complications if not promptly and effectively treated (Belthur, 2022). These infections can lead to prolonged hospital stays, multiple surgical interventions, and, in some cases, permanent limb impairment and disability or life-threatening conditions (Gigante et al., 2019). The World Health Organization (WHO) indicates that pediatric orthopedic infections are the second leading cause of years lived with disability and a major contributor to chronic pain globally (Woods et al., 2024).

There is a wide spectrum of causative pathogens, which vary by age, geographic region, and underlying health conditions. Historically, Staphylococcus aureus, including MRSA, represents the most common isolated microorganism in most types of OM, affecting 50% to 70% of cases of pediatric orthopedic infections (Prieto-Pérez et al., 2014; Trobisch et al., 2022). However, the increasing prevalence of antibiotic-resistant organisms and the increasing emergence of new pathogens like Kingella kingae, pose significant challenges to effective treatment (Dartnell et al., 2012). These newly emergent organisms like Kingella kingae are becoming increasingly common as it has been revealed to be the major bacterial cause of OAI in children aged between 6 and 48 months (Ceroni et al., 2014). The management of these infections often requires a combination of antimicrobial therapy and surgical intervention, making the timing and type of treatment critical to patient outcomes (Woods et al., 2021).

However, data on the prevalence, microbiological profile and impact of pediatric orthopedic infections are limited, particularly in low- and middle-income countries (LMIC), even though there is a belief that these diseases disproportionately affect them where the burden of disease is amplified by limited diagnostic capacity, delayed presentation, and inconsistent adherence to clinical protocols (Sebbag et al., 2019). This study aimed to assess the prevalence, microbiological characteristics, treatment modalities, and clinical outcomes of pediatric orthopedic infections at HFCSUH, thereby addressing existing gaps in local data and informing more effective management strategies.

1.2. Statement of the Problem

Pediatric orthopedic infections, including osteomyelitis and bacterial arthritis, pose a significant clinical and public health concern, particularly in low- and middle-income countries (LMICs), where they contribute substantially to the global burden of disease (GBD) due to the disproportionately large pediatric populations and long years lived with disability (YLD) (Schwend, 2020). These infections account for up to 10–20% of pediatric hospital admissions in LMICs (Belthur, 2022), with osteomyelitis incidence reaching as high as 43 to 200 per 100,000 and bacterial arthritis estimates reaching 20–30 per 100,000 (Joel et al., 2019; Olivier et al., 2019). Studies from Uganda and Malawi report that 3–3.5% of pediatric surgical procedures and up to 10% of outpatient visits are related to osteomyelitis (Lavy et al., 2007; Stanley et al., 2010).

Although mortality associated has declined since the advent of antibiotics, severe cases still result in death due to septicemia and multi-organ failure mainly (Loro et al., 2023). The morbidity, on the other hand, remains high with complications such as chronic infection, pathological fracture, bone loss, growth arrest and deformities affecting up to 60% cases in some regions (Horn et al., 2019; Nunn et al., 2007).Extended Hospital stays-up to 65 weeks – has been reported for children with complicated infections, which is associated with long-term social and psychological repercussions (Bonn, 1994; Horn et al., 2019).

Multiple risk factors contribute to the high burden of musculoskeletal infections in pediatric populations in LMICs, including poverty, poor sanitation, walking barefoot, malnutrition, limited access to healthcare, and high prevalence of comorbid conditions such as HIV/AIDS (Olivier et al., 2019; Robertson et al., 2012). Despite the evident burden, existing measures are limited, with few region-specific studies and inconsistent clinical guidelines in LMIC settings.

In Ethiopia, osteomyelitis and other MSK infections are becoming a major burden and source of disability in many cases (Bizuneh et al., 2023). A study on adult patients with musculoskeletal infections showed that Staphylococcus aureus stood out as the prevailing bacterial strain identified and close to half of adult patients with musculoskeletal infections experienced treatment failure (Gizaw et al., 2025). There is a considerable gap in reliable data concerning the incidence, microbiological profile, treatment practices, and clinical outcomes of pediatric orthopedic infections specifically. Current literature do not adequately address how patient-level and disease-related factors—such as antimicrobial resistance patterns and healthcare access—impact management and recovery. This study aimed to fill these critical gaps by evaluating the prevalence, etiological agents with antimicrobial resistance patterns, management approaches, and clinical outcomes with their major associated factors of pediatric orthopedic infections at HFCSUH.

1.3. Significance of the Study

The primary beneficiary of this study is HFCSUH. Hiwot Fana comprehensive specialized university hospital, now have a set of data regarding the prevalence of pediatric orthopeadics infections and the major etiologic organisms with their antibiotic resistance patterns as well as the current management strategies and the major determinant factors of the outcome of this entities. The findings are very helpful for the development of more targeted and effective treatment plans so that the patients and families will gain from improved diagnosis, treatment, and reduced acute and chronic complications. The findings can also be used by the hospital as a basis to the development of its own antibiogram data so that it can guide and improve the empirical antibiotic choice in the hospital and influence local treatment protocol.

The findings of this study have also the potential to be used by the regional health bureau to influence local healthcare strategies. The program implementers and policymakers at the national level/ ministry of health can be equipped with data from this part of the country to inform infection control strategies and health system improvements. Additionally, researchers and academic institutions can use the finding of this study as a baseline for future studies.

1.4. Objectives

1.4.1. General Objective:

The study aimed to assess the microbiological spectrum, clinical outcomes, and determinants of outcome in pediatric orthopedic infections at Hiwot Fana Comprehensive Specialized University Hospital, Harar, Ethiopia, from January/2022-December/2024.

1.4.2. Specific Objectives:

1. To characterize the microbiological profile with their antibiotics susceptibility patterns of pediatric orthopeadics infections in HFCSUH.
2. To assess the clinical outcome of pediatric orthopedic infections in HFCSUH.
3. To identify factors associated with the poor clinical outcomes of pediatric orthopedic infections in HFCSUH.

2. LITERATURE REVIEW

2.1 Prevalence of Paediatrics Orthopaedic Infections

Pediatric orthopedic infections, such as osteomyelitis and septic arthritis, are common invasive infections that occur widely across the world with greater predilection for developing regions can lead to significant long-term morbidity if not managed effectively (Yi et al., 2021). It is one of the five pediatric orthopedic conditions that contribute to global burden of disease and have implications for musculoskeletal impairment later in life along with trauma, clubfoot, DDH, and cerebral palsy with an estimated burden in children <16 years estimated to be around 2.6% of the population (Schwend, 2020). Osteomyelitis (OM) have been reported to occur with an estimated annual incidence of 1–13 per 100,000 children in developed and up to 200 per 100,000 children in developing countries (Dartnell et al., 2012). The annual incidence of septic arthritis (SA) ranges from 3–5 per 100,000 children in developed while it is 20–30 per 100,000 children in LMICs (Gigante et al., 2019). Pyomyositis, defined as a bacterial intramuscular infection, is another form of pediatric musculoskeletal infection endemic in tropical region with annual incidence of 20–30 per 100,000 children and constituting 2.2–4% of surgical admissions (Shittu et al., 2020).

Paediatrics orthopedic infections in least developed countries, present unique challenges and epidemiological patterns that differ from those in high-income countries representing a significant burden of disease (Adam M. Ali, 2014). It is estimated that there are 12 million children with osteomyelitis in the least developed countries (Schwend, 2020). A Study reviewing samples from five hospitals in Uganda during a 1-year period showed that 10% of all outpatient visits were for osteomyelitis, and 80% of cases were in patients younger than age 20 years. There were 9354 surgical total procedures, with osteomyelitis accounting for 3.5% (Stanley et al., 2010).

Similar to other LMICs, in Ethiopia, Paediatrics MSK infections are expected to represent a heavy burden on health systems and on the society with its significant impact. A Prospective observational study enrolling pediatric patients admitted to Jimma University Medical Center (JUMC), Ethiopia, with a diagnosis of osteoarticular infections from April 30 to October 30, 2019 found that among a total of 150 pediatric patients enrolled in the study, osteomyelitis was diagnosed in 111 (74%), while the rest 39 (26%) had septic arthritis. The majority 105 (70%) of the study participants were male with a mean age of 8.79 ± 4.2 years (Mamo et al., 2021). A hospital based retrospective descriptive cross-sectional study conducted in HFCSUH by retrieving secondary data from January 2018 to February 2021 found a prevalence of osteomyelitis to be 2.89% (Bizuneh et al., 2023). In a hospital-based cross-sectional study which was done between April 15, 2022 and August 15, 2022, in children with an age of 18 years or below, who visited Felege Hiwot Comprehensive Specialized Hospital, the prevalence of chronic osteomyelitis was found to be 86.3% with the tibia and femur being the most commonly involved bones (Mulualem et al., 2023).

2.2 Microbiological Profile of Paediatric Orthopedic Infections and their antibiotic Susceptibility Pattern

The microbiological landscape of pediatric orthopedic infections is diverse, with a range of pathogens responsible for these conditions. Historically, “Staphylococcus aureus” has been identified as the most common pathogen, particularly “methicillin-resistant Staphylococcus aureus” (MRSA) (Liu et al., 2011; Prieto-Pérez et al., 2014; Trobisch et al., 2022; Yi et al., 2021). Studies have consistently shown that MRSA infections are associated with more severe disease and worse outcomes compared to methicillin-sensitive strains (Chen et al., 2025; Liu et al., 2011; Turner et al., 2019). However, the prevalence of MRSA varies by region, with higher rates reported in certain parts of the United States and lower rates in Europe (Saeed et al., 2019). Apart from S. aureus, osteoarticular infections with gram-negative organisms, Group B Streptococcus, and Candida are common in neonates (Liu et al., 2024). In children younger than 4 years, the reported number of cases of K. kingae-associated osteoarticular infections has markedly increased since the 1980s (Ceroni et al., 2014). Other studies have also showed that “Kingella kingae” has been increasingly recognized as a common cause of osteoarticular infections in children under five, suggesting that it may be underdiagnosed due to its fastidious nature and the limitations of traditional culture methods (Anderson De La Llana et al., 2015; Yagupsky, 2012).

Other organisms causing MSK infections in young children include S. pyogenes and S. pneumoniae which are common in older school aged children with osteoarticular infection (Ceroni et al., 2014). The incidence of Hemophilus influenza type-B as a pathogen for osteoarticular infection in young children has decreased noticeably as a result of an effective immunization program against this organism (Gigante et al., 2019). Young children with sickle cell disease have been reported to be particularly susceptible to osteoarticular infections (Gornitzky et al., 2020). Causative organisms include Salmonella, S. aureus and, less commonly, Escherichia coli, Shigella, and S. pneumoniae (Gornitzky et al., 2020; Khan et al., 2018). A retrospective review conducted on medical records at Texas Children's Hospital in Houston from 2000 to 2018, Salmonella was the most common pathogen isolated, accounting for 61% of culture-positive cases followed by Staphylococcus aureus (21.7%) involved in osteoarticular infections of pediatric patients with sickle cell hemoglobinopathies (Kaplan et al., 2019).

In Africa, particularly the sub-Saharan Africa, the microbiological profile of pediatric orthopedic infections often reflects the local health infrastructure, environmental conditions, and endemic diseases. "Staphylococcus aureus" remains the most common pathogen, similar to global trends, but with a higher prevalence of methicillin-resistant "Staphylococcus aureus" (MRSA) in some areas (Ikpeme et al., 2010). However, studies from various regions also highlight the significant burden of gram-negative bacteria, particularly in hospital-acquired infections, which can complicate treatment due to limited antibiotic options (Joel et al., 2019). Notably, infections caused by "Mycobacterium tuberculosis" (TB) remain a significant concern in many parts of Africa, where TB osteomyelitis and septic arthritis are more common than in high-income countries (Omoke & Obasi, 2017). These infections are often challenging to diagnose due to their atypical presentation and the limited availability of advanced diagnostic tools (Ortiz et al., 2024). The burden of TB, particularly in the context of HIV co-infection, adds a layer of complexity to managing orthopedic infections in children (Kamal et al., 2022). Moreover, studies have reported on the presence of endemic pathogens such as "Salmonella species", which are associated with osteomyelitis in children, especially in regions where malaria is prevalent (Horn et al., 2024). The interaction between malaria, sickle cell disease, and invasive bacterial infections like "Salmonella" and "Staphylococcus" creates a distinct epidemiological pattern in sub-Saharan Africa (Olivier et al., 2019).

There is limited published literature specifically focusing the microbiological profile of pediatric orthopedic infections in Ethiopia, but available studies provide some insights into the broader context of infectious diseases and orthopedic care within the country. "Staphylococcus aureus" is a major pathogen responsible for various infections, including those of the bone and joint, complicated with septicemia (Negussie et al., 2015). According to a study done in one of the largest public tertiary hospital in the capital, evaluating the antimicrobial resistance profile of

Staphylococcus aureus shows that the organism exhibits resistance to majority of antimicrobials commonly employed for the treatment of staphylococcal infections (Tadesse et al., 2018). The prevalence of MRSA is also very high especially in the setting of other associated comorbidities like that of HIV/AIDS (Lemma et al., 2015).

An institution-based cross-sectional study conducted from March 1st, 2021 to February 30th, 2022 at Arba-Minch General Hospital evaluating the bacteriological profiles, antimicrobial susceptibility patterns, and associated factors in patients undergoing orthopedic surgery with suspicion of orthopaedic infection showing Staphylococcus aureus was the most frequently isolated bacteria, accounting for 76% and methicillin-resistant was observed in 57.9% and 40% of isolated S. aureus (MRSA) and coagulase negative staphylococci, respectively (Alelign et al., 2022). The research also highlights the presence of gram-negative bacteria like "Escherichia coli" and "Klebsiella" species, which are significant in healthcare-associated infections and may contribute to pediatric orthopedic infections, particularly in hospital settings.

A prospective observational study, done from July 2022-December 2022, investigating the bacterial profile, treatment outcomes, and determinants among patients with musculoskeletal infections admitted to Jimma Medical Center enrolees 160 participants and found that about 94 (58.8%) of patients had microbial growth, of which 75.5% accounts for mono-microbial. The common bacterial isolates were Staphylococcus aureus in (22.4%), Escherichia coli (18.1%), Pseudomonas aeruginosa (14.7) and Klebsiella pneumonia (11.2). The isolated aetiologies were resistant to Ceftriaxone in 67(81.70%) and Ceftazidime in 47(61.8%) of test results (Gizaw et al., 2025). "Mycobacterium tuberculosis" is another significant pathogen in Ethiopia due to the high prevalence of tuberculosis (TB) throughout the country making Tuberculous osteomyelitis and septic arthritis an important considerations in the differential diagnosis of pediatric bone and joint infections to avoid delays in appropriate treatment and associated limb morbidity (Mamo et al., 2021).

2.3 Factors Determining the Clinical Outcomes of Pediatric Orthopedic Infections

The clinical outcomes of pediatric orthopedic infections depend on various factors, including the pathogen involved, the timing of diagnosis as well as treatment, and the adequacy of the management strategy (Yi et al., 2021). Studies have shown that delays in diagnosis and treatment are associated with worse outcomes, including higher rates of chronic infection, growth disturbances, and long-term functional impairments (Ceroni et al., 2014; Spruiell et al., 2017). It is also reported that infection with MRSA have a poor outcome including mortality relative to the MSSA infection to the bone and joints of a pediatric patient (Ju et al., 2011). The introduction of more aggressive management protocols has improved outcomes in recent years, with many children achieving full recovery (Belthur, 2022; Yi et al., 2021). However, complications such as chronic osteomyelitis, joint stiffness, and leg length discrepancies are still reported, particularly in cases involving resistant pathogens or where treatment was delayed (Arnold & Bradley, 2015; Dhar et al., 2020). Long-term follow-up studies are limited, but existing research suggests that even when acute infections are successfully treated, there can be lasting impacts on quality of life and physical function (Horn et al., 2019). This highlights the need for ongoing monitoring and rehabilitation in these patients.

Clinical outcomes for pediatric orthopedic infections in sub-Saharan Africa are generally poorer compared to high-income countries, largely due to delayed diagnosis, limited treatment options and a higher prevalence of complications (Horn et al., 2019; Loro et al., 2023). Chronic osteomyelitis is more common, with studies reporting higher rates of recurrence and long-term disability (Olivier et al., 2019). The impact of comorbid conditions, such as malnutrition, HIV, and sickle cell disease exacerbates the severity of these infections and complicates treatment. For example, children with HIV are at increased risk for severe and recurrent infections mainly due to streptococcus pneumoniae, and their response to standard treatments is often suboptimal (Robertson et al., 2012).

Clinical outcomes for pediatric orthopedic infections in Ethiopia are generally poorer compared to those in high-income countries similar with other LMICs. The combination of delayed diagnosis, limited access to appropriate antibiotics, and inadequate surgical care leads to high rates of chronic infection and long-term disability. A Prospective observational study reported that almost half (45.3%) of the patients had poor treatment outcomes from a total of 150 pediatric patients enrolled in the study (osteomyelitis was diagnosed in 111 (74%), while the rest 39 (26%) had septic arthritis) (Mamo et al., 2021). According to this study, factors associated with poor treatment outcome were comorbidity [AOR=3.3, 95% CI (1.08–10.16)] and use of combination antibiotics [AOR=2.9, 95% CI (1.16–7.3)]. Rural residence [AOR=0.39, 95% CI (0.168–0.92)] and surgical interventions [AOR=0.29, 95% CI (0.006–0.144)] were associated with good treatment outcomes (Mamo et al., 2021).

A hospital based retrospective descriptive cross-sectional study was conducted by retrieving secondary data on assessment of prevalence and treatment outcome of acute and chronic osteomyelitis in all surgical patients in HFCSUH from January 2018 to February 2021 (Bizuneh et al., 2023). According to this study, Out of a total of 41 clinical records with osteomyelitis, 30 (73.2%) were reviewed and the remaining 11 (26.8%) was omitted since the card was missing and was short of relevant information and could not fulfil the inclusion criteria. The majority of osteomyelitis cases (93.3%) were treated with a combination of antimicrobial and surgical interventions, while 6.7% received only antimicrobial treatment. Intravenous antibiotics were administered for less than 2 weeks in 40% of cases, 2-4 weeks in 53.3%, and more than 4 weeks in 6.7%. Of the 28 patients who underwent surgery, 57.1% had Sequestrectomy, 17.9% had surgical debridement, 14.3% had limb amputation, and 10.7% had other procedures. Out of 30 patients, 90% improved and were discharged, 3.3% were referred for further care, 3.3% deteriorated, and 3.3% had no documented outcomes (Bizuneh et al., 2023).

Another, hospital-based cross-sectional study, done between April 15, 2022 and August 15, 2022, in children with an age of 18 years or below at Felege Hiwot Comprehensive Specialized Hospital, Northwest Ethiopia shows, of the total patients with radiological evidence of chronic osteomyelitis, 16.6% had complications/bad outcomes, the most common of which was a pathologic fracture (12.4%). Being male (AOR = 6.162, 95% CI: 1.12–34.147), being over 10 years old (AOR = 4.048, 95% CI: 1.032–15.886), living in a rural area (AOR = 4.046, 95% CI: 1.236–13.364), having a discharging sinus (AOR = 5.237, 95% CI: 1.393–19.693), having a clinical complaint lasting more than 1 year (AOR = 5.189, 95% CI: 1.247–21.588), and a preceding event of trauma (AOR=10.363, 95% CI: 1.101–97.509) were the factors associated with bad outcomes in chronic osteomyelitis (Mulualem et al., 2023).

In addition, the high burden of comorbid conditions, such as malnutrition and infectious diseases like HIV, further complicates the management of orthopedic infections (Gizaw et al., 2025). Malnourished children are particularly vulnerable to severe infections and have poorer outcomes, which underscores the need for integrated healthcare approaches that address both infectious diseases and nutritional support.

2.4 Conceptual framework

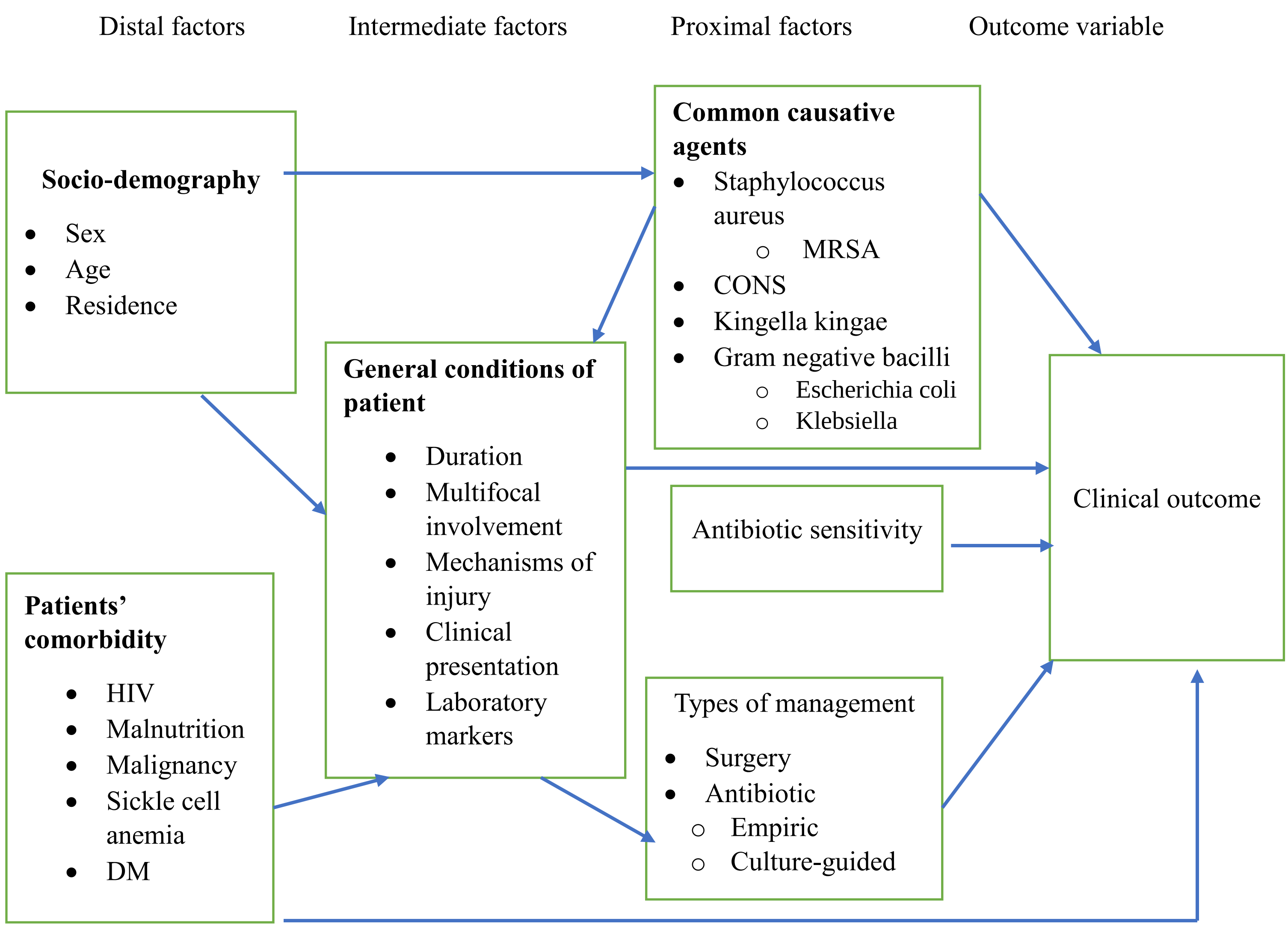


Figure 1- *Conceptual framework of Pediatric Orthopedics Infection: The, microbiological profile, clinical outcomes and factors associated with the clinical outcomes in Hiwot fana comprehensive specialized university hospital, Harar, Ethiopia*

3. METHODS

3.1 Study Area and Period

This study was conducted in Harar city which is located in Eastern Ethiopia, 526kms from Addis Ababa. HFCSUH, located in Harar, is one of the oldest health institutions in Eastern part of Ethiopia. The hospital has been transferred to Haramaya University to serve as, a teaching, community serving, referral and research hospital. It serves a diverse population of around 5 million. It offers specialty in Surgery, Internal Medicine, Obstetrics and Gynecology, Pediatrics, Emergency and critical medicine, Anesthesiology, Orthopedics. Additionally, the hospital delivers services with different subspecialty level such as Radiology, Dermatology, Pathology, Oncology, Neurology, Neurosurgery, Plastic surgery, Pediatric surgery and ENT (Ear, Nose & Throat). It is the teaching Hospital for Haramaya university collage of health and medical science dedicated to comprehensive healthcare that prioritizes both treatment and prevention, with an emphasis on community health education. Orthopeadics department is one of the departments of the hospital and there are total of 14 orthopeadics and trauma surgery residents from first year to fourth year practicing in the hospital. In general, this hospital plays a vital role in enhancing health outcomes and training healthcare professionals, significantly advancing healthcare services in its region. The study was conducted from February 09, 2026-February 30, 2026 in the pediatrics and orthopedics wards of HFSCUH.

3.2 Study Design

An institution based cross-sectional retrospective study design was employed using quantitative methods.

3.3 Population

3.3.1 Source population

The source population was all pediatric patients (≤18 years) who visited HFCSUH with orthopeadics compliant and/or have got orthopeadics consultation between January/2022-December/2024.

3.3.2 Study Population

The study population was patients (≤18 years), with any form of orthopedic/Musculoskeletal infection who visited and treated in HFCSUH between January/2022-December/2024 fulfilling the inclusion criteria.

3.4 Inclusion and Exclusion Criteria

3.4.1 Inclusion Criteria

All pediatrics patients' ≤18 years old, diagnosed and treated for musculoskeletal infection in HFCSUH between January/2022-December/2024 and whose medical records contain complete information were included in the study.

3.4.2. Exclusion criteria

Patients whose initial diagnosis changed to other medical conditions were excluded. Pediatric patients with surgical site infection (not including fracture related infections) and diabetic foot ulcers are excluded too.

3.5. Sampling and Sample Size Determination

3.5.1. Sample Size Determination

To determine the sample size for this study; outcome variables and the factors that were significantly associated with the outcome variables were considered. The sample size for each specific objective was calculated separately and the one with the largest number was used after adding 10% non-response rate as follows-

For Specific Objective one (prevalence)

The sample size was calculated using single population proportion formula using prevalence of osteomyelitis, P as 74% from study conducted in Jimma (Mamo et al., 2021), with the margin of error (d) - 0.05, confidence interval -95% and (Zά/2) - 1.96, as follows:-

$$\frac{(Z\alpha/2)^2 * (p*q)}{d^2} = \frac{3.84*0.74*0.26 =}{0.05^2}$$ **296 patients**.

For Specific Objective two (Microbiological profile)

The sample size was also calculated using single population proportion formula using prevalence staphylococcus aureus infection P as 76% from study conducted in Arba-Minch evaluating the bacteriological profiles and antimicrobial susceptibility patterns (Alelign et al., 2022), with the margin of error (d) - 0.05, confidence interval -95% and (Zά/2) - 1.96, as follows:-

$$\frac{(Z\alpha/2)^2 * (p*q)}{d^2} = \frac{3.84*0.24*0.76 =}{0.05^2}$$ **280 patients.**

For Specific Objective three (Management strategy)

The sample size was again calculated using single population proportion formula using the proportion of patients that receive both antimicrobial agents and surgery as a treatment strategy P as 93.3% from study conducted in HFCSUH (Bizuneh et al., 2023), with the margin of error (d) - 0.05, confidence interval -95% and (Zά/2) - 1.96, as follows:-

$$\frac{(Z\alpha/2)^2 *(p*q)}{d\text{^}2} = \frac{3.84*0.067*0.933}{0.05\text{^}2} = \textbf{96 patients.}$$

For Specific Objective Four (Factors determining clinical outcomes)

Double population proportion formula was used to calculate the sample sizes as follows-

Table 1- *Sample size Calculation of Factors Associated with clinical outcomes of pediatrics orthopeadics infections*

Factors Associated	**Assumptions**	**Proportion (% of unexposed with poor outcome**	**AOR**	**Sample size (Double proportion formula)**	**After 10% Non-respondent**	**Reference**
Comorbidity	CI= 95% Power= 80% Ratio= 1	76.5	3.3	212	**233**	(Mamo et al., 2021)
Rural residence	CI= 95% Power= 80% Ratio= 1	33.1	4.05	80	**88**	(Mulualem et al., 2023)
Preceding event of trauma	CI= 95% Power= 80% Ratio= 1	73.1	10.36	88	**97**	(Mulualem et al., 2023)
Clinical compliant>/=1 year	CI= 95% Power= 80% Ratio= 1	37.9	2.95	126	**139**	(Mulualem et al., 2023)

In Conclusion, the sample size for specific objective one, n= **296,** was taken as a final sample size for the study as it is the largest of all calculated sample sizes.

For incomplete data and loss of charts, the PI used 10% of contingency; therefore the total sample size calculated to be used was **326**.

3.5.2. Sampling Technique

All consecutive patients from birth up to 18 years of age who presented to the orthopedics and/or pediatric outpatient and inpatient departments during the study period and were diagnosed and treated for orthopedic infections were included. Eligible participants fulfilling the inclusion criteria were recruited, and secondary data were retrieved from their medical records and follow-up sheets

In total, there were 970 pediatrics patients (≤18 years) who had orthopeadics consultation during the study period. 362 patient charts of children aged 0–18 years that were seen and treated for orthopedic infections at HFCSUH between January 2022 and December 2024 were initially retrieved. After a thorough review, 51 charts were excluded due to incompleteness and/or failure to meet the inclusion criteria. Consequently, 311 patient charts fulfilled the eligibility requirements and were included in the final analysis (95.4% response rate). The process of chart retrieval and selection is summarized in **Figure 2**.

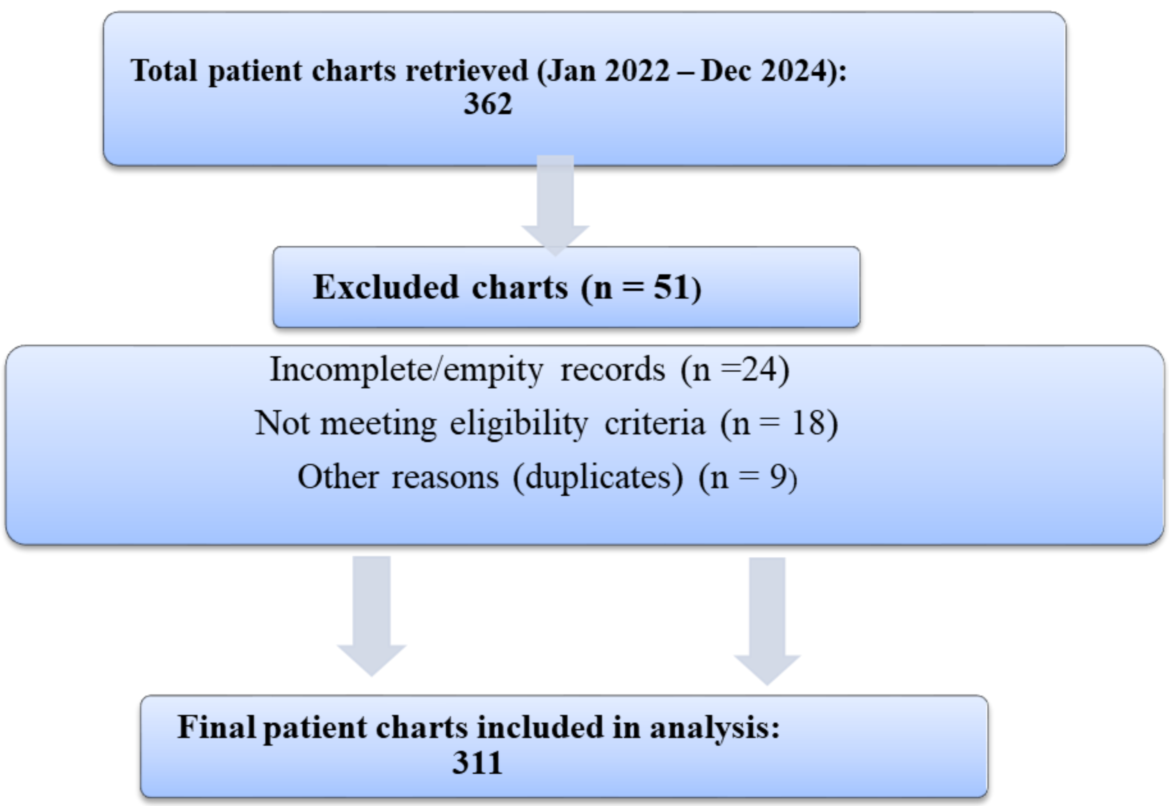


Figure 2- *Flow diagram of patient chart retrieval and selection process*

3.6. Data Collection Technique and Supervision

3.6.1. Data Collection Tools

Pretested structured data collection checklist adapted from different relevant published literatures (Bizuneh et al., 2023; Huang et al., 2019; McNeil, 2020) was used to collect data retrospectively. Sources included hospital records, patient charts, operating room registries, morning and weekly control session reports and discharge summaries. Extracted variables covered about the socio-demographic data's such as age, sex, residence as well as comorbidities, the clinical presentation history including symptoms and duration of symptoms, history of previous antibiotic exposure and visit to traditional healers. Diagnostic tests: results from microbiological cultures & drug sensitivity pattern, imaging studies (e.g., X-rays, US), and laboratory markers (e.g., complete blood counts, inflammatory markers). Treatment details: type of antibiotics used, route and duration, surgical interventions performed. Outcome measures: in-hospital and follow-up complications and the final clinical outcome were also sought from the follow up sheets of the medical records.

3.6.2. Data Collectors and Supervisors

Data was collected by four medical interns by reviewing the medical record of pediatric patients admitted and/or treated for musculoskeletal infections during the study time period. Training to data collectors was given on the objective of the study, variables and their measurements before starting the data collection. All data collection activities were supervised by the principal investigator.

3.6.3. Data Collection Procedure

Medical records of pediatric patients who were seen at NICU, pediatric emergency and outpatient orthopedic referral clinic or admitted to pediatrics and orthopeadics ward of HFCSUH with a diagnosis of musculoskeletal infection from January/2022 to December/2024 were initially identified from the log-books/registers of the respective work area, from which card number of patients was obtained and then the medical records/charts were retrieved from the card room. Using the medical record number as a reference, eligible patients were identified, and with their charts reviewed thoroughly, relevant demographic information, clinical, laboratory, microbiological and imaging findings, and treatment details including the type of antibiotics used, route of administration and duration and surgical interventions performed, and supportive care provided as well as clinical outcome information complications, duration of hospital stay, and follow-up outcomes was gleaned from their medical records and follow-up sheets. Some relevant data including the radiologic images/findings are also retrieved from morning and weekly control session reports of some included patients when reports are not available in the medical record/chart.

3.7. Study Variables

3.7.1. Dependent Variable

- Microbiologic profile of Pediatric Orthopedic Infections
- Clinical Outcomes of Pediatric Orthopedic Infections

3.7.2. Independent variable

- Socio-demographic (age, sex, residence/address)
- General conditions of the patient (affected area, mode of onset, clinical presentation)
- Other factors (Time from presentation to the treatment, tradition healers, taking antibiotics before coming to hospitals, Orthopedic implant)
- Comorbidities (Diabetes, HIV, malignancy, malnutrition)
- Microbiological Profile and Antibiotic Susceptibility Pattern of Pediatric Orthopedic Infections
- Patients' management (types of treatment given, route, duration)

3.8. Operational Definitions

Pediatric Patient- A patient less than and including 18 years of age

Orthopaedic Infection- Any suspected/diagnosed infectious process affecting the musculoskeletal system (bone, joint, Muscle or other soft tissue structures of the extremities/spine) of the human body (Arnold & Bradley, 2015).

Case Identification: Patients were identified by reviewing medical records of all pediatric patients (0-18 years) with a documented diagnosis of any musculoskeletal infection during the study period (January 2022–December 2024). The diagnosis recorded by the attending physician in the medical record was accepted as the final diagnosis for this study.

Specific Diagnoses: (as documented in medical records).

Acute Osteomyelitis: Osteomyelitis documented as "acute" in the diagnosis or presenting with symptoms lasting ≤14 days, characterized by acute inflammation, fever, and absence of sequestrum or involcrum on radiography (Arkader et al., 2016).

Chronic Osteomyelitis: Osteomyelitis documented as "chronic" in the diagnosis, or presenting with symptoms >14 days or with radiographic findings of sequestrum, involcrum, or cloaca(Arkader et al., 2016).

Septic Arthritis: Documented infection of any joint space (Arkader et al., 2016). Measured as a "yes" or "no" question.

Pyomyositis: Documented infection of skeletal muscle (Arkader et al., 2016). Measured as a "yes" or "no" question.

Combined Infections: Documented presence of different types of MSK infectious processes e.g., osteomyelitis with concomitant septic arthritis (Belthur, 2022). It is measured as a multiple response question.

Necrotizing Fasciitis: Documented severe soft tissue infection involving fascia (Belthur, 2022).

Fracture related infections: Documented infection arising at any time following a fracture or fracture fixation excluding other post-surgical infections or surgical site infections (Loro et al., 2023).

Myecetoma (e.g. Madura foot) - Documented musculoskeletal infection caused by fungus or actinomycetes (Belthur, 2022).

Other Soft tissue infections: A documented MSK infection in a pediatrics patient other than mentioned above such as other non-necrotizing soft tissue infections, superficial abscess collections, and infected soft tissue injuries.

Prevalence: The proportion of patients with a documented orthopedic infection among all pediatric patients presenting with musculoskeletal complaints to HFCSUH from January/2022 to December/2024, calculated using data from the hospital's Health Management Information System (HMIS).

Microbiological Profile:

- **Organism Identification**: Genus and species of all microorganisms isolated from cultures (blood, tissue, and aspirate).
- **Antibiotic Susceptibility**: Antibiotic susceptibility testing results (e.g., Sensitive, Resistant) based on standard methods like Kirby-Bauer disk diffusion or MIC testing, interpreted per Clinical and Laboratory Standards Institute (CLSI) guidelines (Bailey, 2024). If the test for a specific antibiotics is not reported- take as not done.
- **MSSA vs. MRSA**: Specifically, Staphylococcus aureus isolates will be classified as Methicillin-Sensitive (MSSA) or Methicillin-Resistant (MRSA) based on oxacillin/cefoxitin disk testing or equivalent.

Management Strategy:

- **Medical Management**: (Yes/No)
    - The type of antibiotics , the Choice of the empirical antibiotic choice (agent(s)), (ceftriaxone based or not), route and duration of Therapy
- **Surgical Management**: (Yes/No)
    - Type of Procedure, timing of Emergency Surgery: (time interval (in hours) from presentation to the first emergency surgical procedure).

Treatment Outcomes:

- Good Outcome: Resolution of clinical signs (afebrile, no pain, normalized function) and recovery with the infection declared controlled (recovered) without persistence or recurrence of the infection and/or Recovery with minor residual complications that do not significantly impact function during the last follow-up (Yi et al., 2021).

- Poor Outcome: Unresolved/persistent/reappearing infection or major complication (i.e. residual complication affecting function and requiring further intervention) at final follow-up OR death attributable to the orthopedic infection or its complications OR lost to follow-up (no follow-up documentation available after discharge)(Yi et al., 2021).

Associated Factors:

- Demographic: Age, sex, residence
- Clinical:
  - ✓ Duration of symptoms prior to presentation
  - ✓ Late presentation: Defined as presentation >7 days after onset of symptoms (Belthur, 2022).
  - ✓ Presence of fever: Documented temperature >37.5°C at presentation or reported fever at home (Bailey, 2024).
  - ✓ Involved anatomical site: Specific bone, joint, or soft tissue structure affected.
  - ✓ Multifocal involvement: Involvement of multiple anatomical sites, either in the same limb, contralateral limb, or distant sites.
  - ✓ Mode of onset: Hematogeneous, traumatic, contagious, or other.
  - ✓ Mechanism of injury: For traumatic cases (falling down accident, road traffic accident, pin prick/thorn injury, farm injury, etc.).
  - ✓ Visit to traditional healers: Documented history of consulting traditional healers prior to hospital presentation.
  - ✓ Prior antibiotic exposure: Documented history of antibiotic use prior to the index admission.

- Laboratory:
  - ✓ Anemia: Categorized based on hemoglobin level (adjusted for age)(Bailey, 2024; Lyle et al., 2022):
    - Severe anemia: Hemoglobin < 7 g/dL
    - Moderate anemia: Hemoglobin 7-9.9 g/dL
    - Mild anemia: Hemoglobin 10-10.9 g/dL (for children <5 years) or 10-11.4 g/dL (for children ≥5 years)
    - No anemia: Hemoglobin above thresholds
  - ✓ Leukocytosis: White blood cell count adjusted for age(Bailey, 2024; Lyle et al., 2022), further categorized as:
    - Leukocytosis: WBC 1.0-1.5 times upper normal value for age (17,000/µL (< 2 years), 15,000/µL (2-6 years), 13,500/µL (6-12 years), 11,500/µL (>12 years).
    - Marked leukocytosis: WBC >1.5 times upper normal value for age.

- ✓ C - reactive protein (CRP): Elevated if >20 mg/L (Lyle et al., 2022).
- ✓ Erythrocyte Sedimentation Rate (ESR): Elevated if >20 mm/hr (Lyle et al., 2022).

- Radiological:
- Microbiological:
  - ✓ Culture result: Positive (monomicrobial or polymicrobial) or negative/no growth.
  - ✓ MRSA infection: Isolation of methicillin-resistant Staphylococcus aureus from any culture.
- Treatment-related:
  - ✓ Type of management: Medical management alone vs. combined medical and surgical management.
  - ✓ Delay in emergency surgical care: Time from presentation to first emergency surgery exceeding 6 hours (Woods et al., 2024).
  - ✓ Antibiotic regimen type: Empirical (before culture results) vs. definitive (culture-guided).
  - ✓ Antibiotic choice: Specific agents used, particularly ceftriaxone-based vs. non-ceftriaxone regimens.
  - ✓ Route of administration: IV only, oral only, or IV then oral transition.
- Comorbidities: Presence/Documented diagnosis of immunocompromising conditions (e.g., sickle cell disease, malnutrition, DM, HIV, malignancy, chronic renal failure).

3.9. Data Quality Control

A pretested standard data collection checklist was prepared. To ensure data validity, reliability and safety, a digital mobile app ODK with the standardized data collection forms was utilized to which the collected data was transferred to the data base after daily checks are made to on the accuracy, completeness, and accurate identification of the needed information in the Checklist. Both staffs involved in the data collection process received training to minimize inter-observer variability. Regular audits and cross-checks were being conducted to uphold the quality and accuracy of the data.

3.10. Data Analysis

Data were analyzed using SPSS version 27. Descriptive statistics (frequencies, percentages, means with SD, medians with IQR) were used to summarize socio-demographic characteristics, clinical presentations, microbiological profiles, management strategies, and outcomes. Prevalence was calculated using HMIS data. Microbiological data were analyzed by calculating isolation frequencies and antibiotic susceptibility proportions. MRSA was defined as oxacillin-resistant S. aureus. Subgroup analyses were performed for major diagnostic categories.

Bivariate analysis employed Chi-square/Fisher exact test for categorical variables and independent t-tests or Mann-Whitney U tests for continuous variables to identify factors associated with treatment outcome. Crude odds ratios (COR) with 95% confidence intervals were calculated.

Variables with $p < 0.25$ in bivariate analysis were entered into binary logistic regression using backward stepwise elimination to identify independent predictors of poor outcome. Adjusted odds ratios (AOR) with 95% CI were calculated, and statistical significance was set at $p < 0.05$. Model fitness was assessed using the Hosmer-Lemeshow test.

3.11. Ethical Considerations

Ethical clearance was obtained from Institutional Health Research Ethics Review Committee (IHRERC) of Haramaya University, college of health and medical sciences with reference number (Ref.No. IHRERC/009/SOM/2026). Then, letter for cooperation and permission was delivered to HFCSUH administration to get permission for the study. Throughout the data collection process, confidentiality and privacy was upheld, and no personal identifiers were recorded on the checklist. Confidentiality of individual participant's information was also assured by using unique identifiers and limiting access to the principal investigator and research assistants of study information. And patient's card returned to card room as soon as data collection format was filled which helps in securing patients information

3.12. Plan for Information Dissemination

The result of the study will be presented to Haramaya University community as part of dissertation defense and it will be disseminated to Haramaya University College of health and medical science, Haramaya university library, Harari regional Health Bureau and to the targeted health facility. Further attempt will be made to publish it on national and international scientific journals**.**

4. RESULTS

4.1 Epidemiology and Clinical Characteristics of Study Participants

4.1.1 General prevalence and Socio-Demographic Characteristics of pediatrics Orthopaedic infections

A total of 311 patients met the inclusion criteria and were included in the study and analyzed. Of these, 311 were diagnosed with orthopedic infections, corresponding to a prevalence of **32.1%** within the orthopedic subgroup.

Table 2*: The Socio-demographic characteristics of the study participants of "Pediatric Orthopedic infections" in HFCSUH, Harar, Ethiopia from January /2022 – December 2024*

Variables	Category	Frequency (N)	Percentage (%)
Age group	0-2 yrs.	19	6.1 %
	2-6 yrs.	34	10.9 %
	6-12 yrs.	121	38.9 %
	12-18 yrs.	137	44.1 %
Sex	Male	224	72.0 %
	Female	87	28.0 %
Residency	Urban	88	28.3 %
	Rural	223	71.7 %

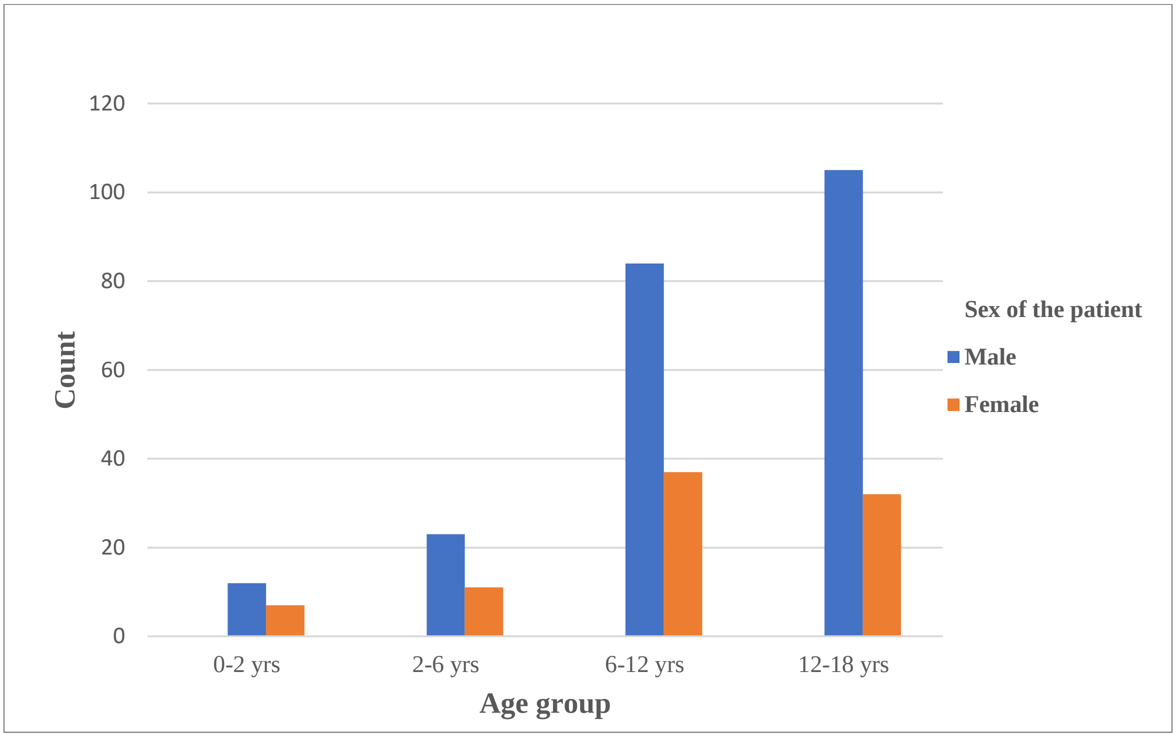


Figure 3- *Distribution of patients by age group and sex*

The age of participants ranged from 0.2 to 18 years, with a mean age of 11.2 years (SD = 4.86) and distribution showing a slight negative skewness (-0.416). When stratified by age groups, the largest proportion of patients were observed in the 12–18 years age category (44.1%), followed by the 6–12 years age group (38.9%). In terms of sex and place of residence, 224 (72.0%) were male and the majority of patients were from rural areas (223; 71.7%) **(Table 2, Figure 3)**.

4.1.2 Socio-demographic and Clinical Characteristics by diagnosis of Study Participants

Table 3- *The distribution of Specific orthopeadics infections in pediatric patients from January, 2022-December, 2024.*

Specific Diagnosis	Frequency	Percent (%)
Chronic Osteomyelitis	91	**29.3**
Septic Arthritis	51	**16.4**
Acute Osteomyelitis	33	**10.6**
Pyomyositis	22	**7.1**

Necrotizing Fasciitis	20	**6.4**
Fracture Related Infection	19	**6.1**
Acute Osteomyelitis with Concurrent Septic Arthritis	14	**4.5**
Chronic Osteomyelitis with Concurrent Septic Arthritis	5	**1.6**
Gas Gangrene (Myonecrosis)	2	**0.6**
Myecetoma (Deep Fungal infection)	2	**0.6**
TB Arthritis	1	**0.3**
Other Soft tissue infections including Abscess collection	51	**16.5**

With respect to the specific diagnosis, chronic osteomyelitis was the most frequent diagnosis, accounting for 91 cases (29.3%). accounting for 91 cases (29.3%). Septic arthritis and acute osteomyelitis accounts 16.4% (51 cases) and 10.6% (33 cases) cases) and 10.6% (33 cases) respectively. Pyomyositis comprised 22 cases (7.1%), while necrotizing fasciitis comprised 20 cases necrotizing fasciitis comprised 20 cases (6.4%). Other soft tissue infections, including abscess collections, represented 51 cases collections, represented 51 cases (16.4%) (

Table 3).

Table 4- *The Socio-demographic and Clinical characteristics of patients with Chronic Osteomyelitis in HFCSUH, Harar, Ethiopia from January /2022 – December 2024.*

Variables	Category	Frequency (N)	Percentage (%)
Age group	0-2 yrs.	2	2.2 %
	2-6 yrs.	6	6.6 %
	6-12 yrs.	42	46.2 %
	12-18 yrs.	41	45.1 %
Sex	Male	70	76.9 %
	Female	21	23.1 %
Residency	Urban	12	13.2 %

	Rural	79	86.8 %
Involved Bone	Tibia	32	35.2 %
	Femur	25	27.5 %
	Humerus	11	12.1 %
	Fibula	6	6.6 %
	Ulna	4	4.4 %
	Others.	13	14.3 %
"Cearny-Mader" classification	Type III	57	62.6 %
	Type IV	11	12.1 %
	Type II	10	11.0 %
	Type I	8	8.8 %
	Not Applicable	5	5.5 %
Presenting Symptoms	Pain	89	97.8 %
	Discharging Sinus	85	93.4 %
	Limitation of Function	49	53.8 %

Chronic Osteomyelitis was diagnosed in 91 patients, with a mean age of 11.7 years (SD = 4.01). When stratified by age groups, the largest proportion of patients with chronic osteomyelitis were observed in the 6–12 years age category (46.2%), followed by the 12–18 years age group (45.1%). In terms of sex and place of residence, 70 (76.9%) were male and the majority of patients were from rural areas (79; 86.8%). The Tibia, Femur and Humerus are the three most commonly involved bones encompassing 35.2%, 27.5 %, and 12.1% of the cases. The majority of the cases of chronic osteomyelitis studied fall in to Type-III (57 cases, 62.6%) under the "Cearny & Mader" classification scheme (

Table 4).

Table 5- *The Socio-demographic and Clinical characteristics of patients with Septic Arthritis in HFCSUH, Harar, Ethiopia from January /2022 – December 2024.*

Variables	Category	Frequency (N)	Percentage (%)
Age group	0-2 yrs.	6	11.8 %
	2-6 yrs.	6	11.8 %
	6-12 yrs.	15	29.4 %
	12-18 yrs.	24	47.1 %
Sex	Male	33	64.7 %
	Female	18	35.3 %
Residency	Urban	25	49.0 %
	Rural	26	51.0 %
Involved Joint	Knee Joint	29	56.9 %
	Hip Joint	9	17.6 %
	Elbow Joint	6	11.8 %
	Shoulder Joint	4	7.9 %
	Ankle Joint	3	5.9 %
Presenting compliant (commonest)	Swelling	51	100 %
	Pain	49	96.1 %
	Limitation of Function	48	94.1 %

Septic Arthritis was diagnosed in 51 patients, with a mean age of 11.1 years (SD = 5.64). The largest proportion of patients were observed in the 12–18 years age category (47.12%), followed by the 6–12 years age group (29.4%). In terms of sex and place of residence, 33 (64.7%) were male and 26 patients (51%) were from rural areas (79; 86.8%). The Knee joint was involved in 29 cases (56.9%) followed by Hip joint (9 cases; 17.6%) (**Table 5**).

Table 6*- Socio-demographic and Clinical characteristics of patients with Acute Osteomyelitis in HFCSUH, Harar, Ethiopia from January /2022 – December 2024.*

Variables	Category	Frequency (N)	Percentage (%)
Age group	0-2 yrs.	1	3.0 %
	2-6 yrs.	12	36.4 %
	6-12 yrs.	15	45.5 %
	12-18 yrs.	5	15.2 %
Sex	Male	23	69.7 %
	Female	10	30.3 %
Residency	Urban	13	39.4 %
	Rural	20	60.6 %
Involved Bones	Tibia	19	57.6 %
	Femur	10	30.3 %
	Humerus	3	9.1 %
	Radius	1	3.0 %
Presenting Complaints (common)	Pain	33	100 %
	Swelling	30	90.9 %
	Fever	28	84.8 %

Acute Osteomyelitis was diagnosed in 33 patients, with a mean age of 7.8 years (SD = 3.76). When stratified by age groups, the largest proportion of patients with acute osteomyelitis were observed in the 6–12 years age category (45.5%), followed by the 2–6 years age group (36.4%). In terms of sex and place of residence, 23 (69.7%) were male and the majority of patients were from rural areas (20; 60.6%). The Tibia, Femur and Humerus are again the three most commonly involved bones with acute osteomyelitis encompassing 57.6%, 30.3%, and 9.1% respectively (**Table 6**).

4.1.3 Clinical Presentation and Investigation profile of the study participants

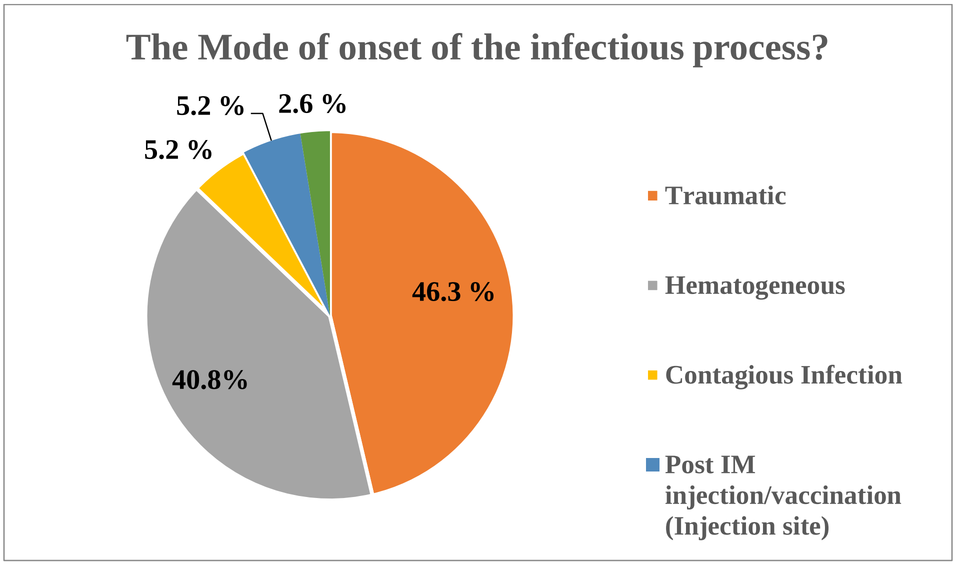


Figure 4- *The distribution of Mode of onsets of orthopeadics infections in pediatric patients from January, 2022- December, 2024.*

Table 7- *Clinical characteristics of patients with Pediatric orthopeadics infections in HFCSUH, Harar, Ethiopia from January /2022 – December 2024.*

Variables	Category	Frequency (N)	Percentage (%)
Late Presentation (Presentation > 7 days of onset of symptoms)	Yes	200	64.3 %
	No	111	35.7 %
Previous Antibiotic therapy (prior to the index admission)	Yes	124	39.9 %
	No	187	60.1 %
Visit to Traditional Healers	Yes	87	28.0 %
	No	224	72.0 %
Comorbidities (Any, including Malnutrition)	Yes	80	25.7 %
	No	231	74.3 %
Malnutrition	Severe Malnutrition	20	6.4 %
	Moderate Malnutrition	32	10.3 %
	Mild Malnutrition	12	3.9 %
	No Malnutrition	247	79.4 %
Diabetes Mellitus	Yes	15	4.8 %
	No	296	95.2 %

Of the 311 patients studied 144 (46.3%) had a traumatic mode of onset while 127 cases (40.8%) had a hematogeneous mode of onset (**Figure** 4). Among the traumatic ones, falling down accident was the most commonly listed mechanism of injury (46 (31.9%)). It is followed by road traffic accident (30 (20.8%)), pin prick or thorn injuries (28 (19.4%)) and farm injury (13 (9.0%)).

The commonest presenting compliant was pain which was observed in 307 patients (98.7%). It is followed by localized swelling (230; 74.0%) and limitation of movement or limb use in 63% (196) patients. Fever, as a presenting compliant was recorded in 156 (50.2%) of the total patients. For patients with Chronic Osteomyelitis, pain was again the commonest presenting compliant found (89 cases, 97.8%) followed nearly by a discharging sinus seen in 85 patients (93.4%). Some other variables on clinical and laboratory presentation are summarized in **Table 7** and **Error! Not a valid bookmark self-reference.**.

Table 8- *Laboratory and radiographic characteristics of patients with Pediatric orthopeadics infections in HFCSUH, Harar, Ethiopia from January /2022 – December 2024.*

Variables	Category	Frequency (N)	Percentage (%)
Level of Hemoglobin (Anemia)	Severe Anemia	10	3.2 %
	Moderate Anemia	84	27.0 %
	Mild Anemia	80	25.7 %
	No Anemia	137	44.1 %
Leukocytosis	Marked leukocytosis	53	17.0 %
	Leukocytosis	128	41.2 %
	No Leukocytosis	130	41.8 %
Raised CRP (>20 mg/l)	Yes	206	66.2 %
	No	7	2.3 %
	Not done (Missing)	98	31.5 %
Raised ESR (>20 mm/hr.)	Yes	285	91.6 %
	No	5	1.6 %
	Not done (Missing)	21	6.8 %
X-ray (Radiography)	With Finding	186	59.8 %
	Normal X-ray	44	14.1 %
	Not Available (found)	81	26 %

Common x-ray findings	Soft tissue swelling	104	45.2 %
	Sequestrum	73	31.7 %
	Periosteal reaction	70	30.4 %
	Involcrum	65	28.2 %
Implant in the bone	No implant	300	96.5 %
	Intramedullary Nail	6	1.9 %
	Plate & Screw	2	0.6 %
	Compression Hip Screw	1	0.3 %
	Pins (K-wires)	1	0.3 %
	External Fixator	1	0.3 %

4.2 Microbiological Profile and Antibiotic Susceptibility Pattern

4.2.1 Microbiological profile of Pediatrics Orthopedics infection

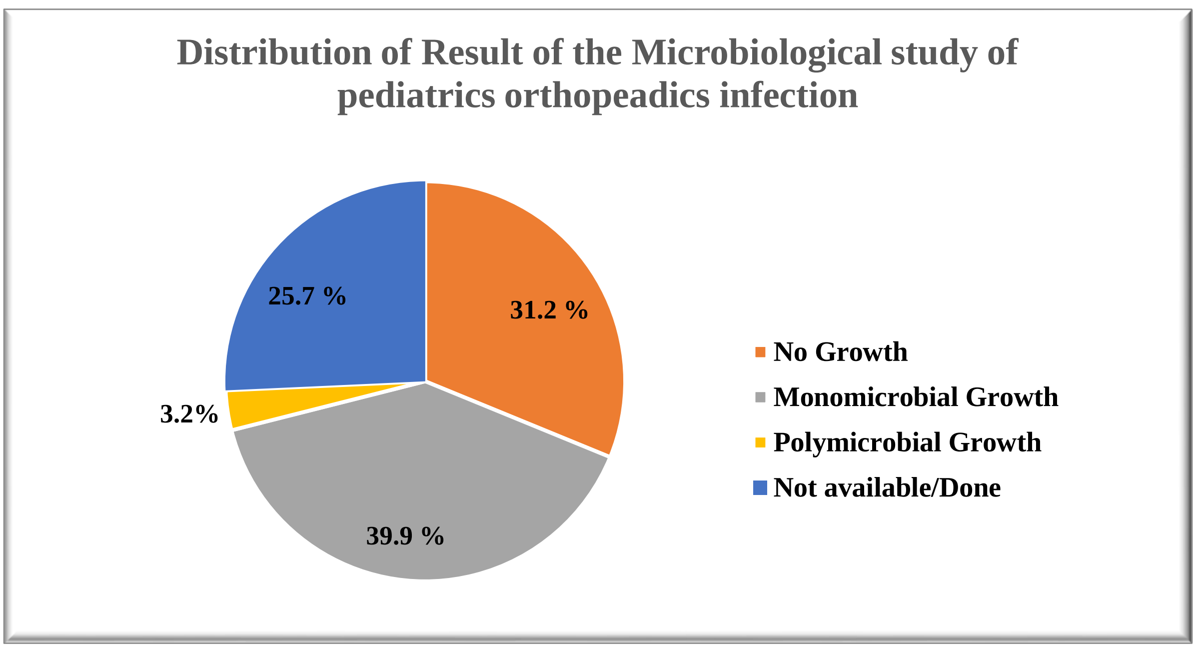


Figure 5*- The distribution of the result of microbiological study of orthopeadics infection of pediatric patients from January, 2022- December, 2024.*

Microbiological culture results were available for the majority of patients, although not universally. Out of 311 cases, cultures were documented in **231 (74.3%),** while in 8**0 patients**

(25.7%) no culture or susceptibility testing was performed. Among the available reports, **124 cases (53.7%)** demonstrated monomicrobial growth, whereas 10 cases (4.3%) showed polymicrobial growth, reflecting mixed infections. Notably, 97 cultures (42.0%) yielded no growth (**Figure** 5).

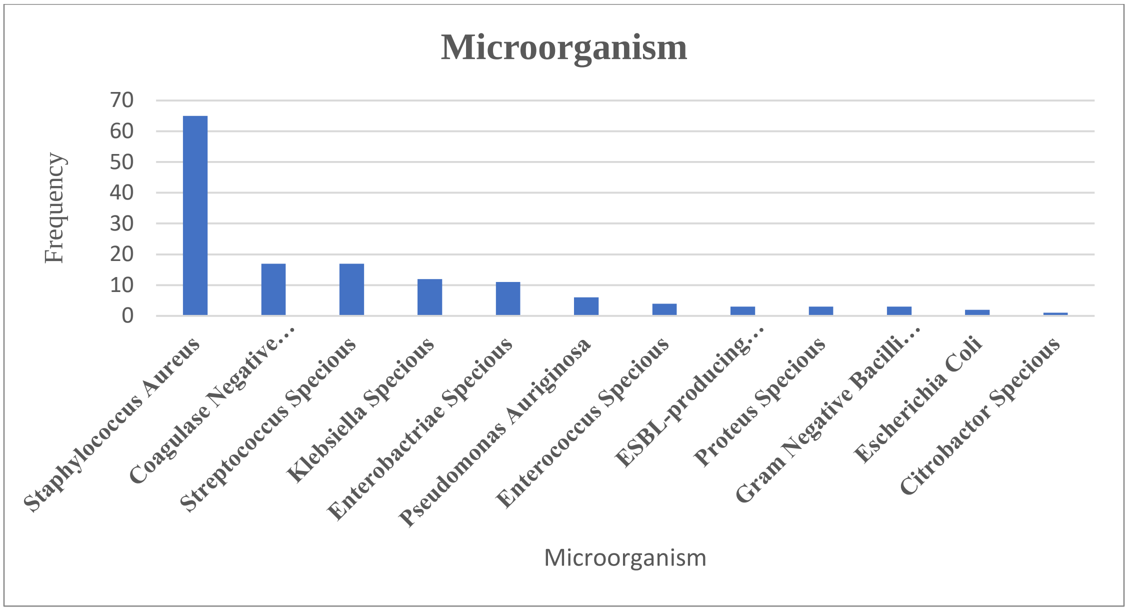
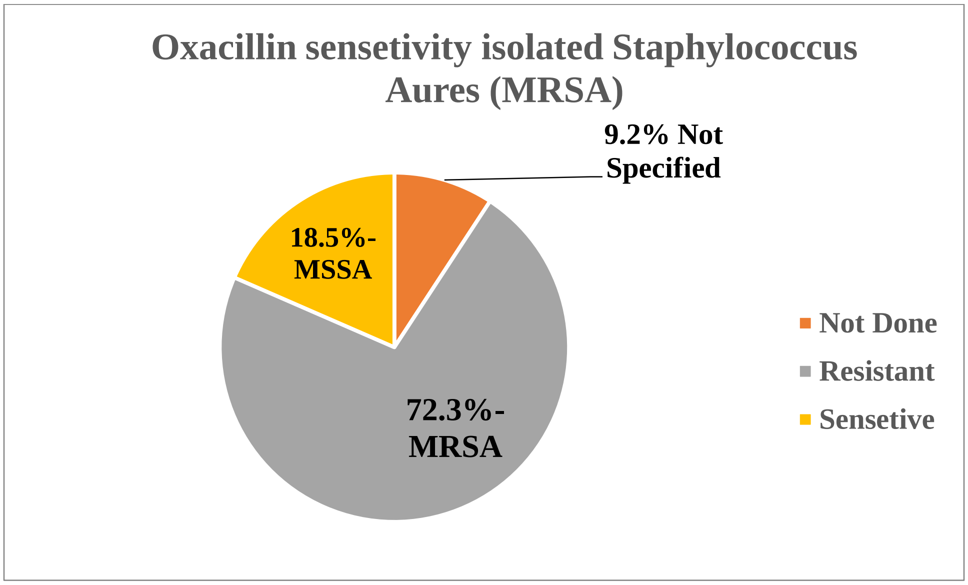


Figure 6- *The distribution of specific bacterial pathogens of orthopeadics infection in pediatric patients from January, 2022- December, 2024.*

From the 134 culture positive cases, 144 isolates were identified. Staphylococcus aureus was the predominant pathogen, accounting for 65 cases (45.1%). Coagulase-negative staphylococci and Streptococcus species were the next most frequent, each contributing 17 isolates (11.8%). Gram-negative organisms were also represented, including Klebsiella species (8.3%), Enterobacter species (7.6%), and Pseudomonas aeruginosa (4.2%). Less common isolates included Enterococcus species (2.8%), ESBL-producing Enterobacteriaceae (2.1%), Proteus species (2.1%), unspecified Gram-negative bacilli (2.1%), Escherichia coli (1.4%), and Citrobacter species (0.7%) (**Figure** 6).



Abbreviation: MSSA- Methicillin Sensitive Staphylococcus Aureus; (MRSA- Resistant)

Figure 7*- The oxacillin sensitivity status of staphylococcus aureus bacterial isolate in orthopeadics infection of pediatric patients from January, 2022- December, 2024.*

Among the Staphylococcus aureus isolates, methicillin resistance based on sensitivity to antibiotic Oxacillin was highly prevalent. Out of 65 cases, 47 (72.3%) were identified as MRSA, while only 12 (18.5%) were methicillin-sensitive strains and oxacillin sensitivity was not done for 6 (9.2%) isolates of staphylococcus aureus (**Figure**).

Table 9*- Commonly isolated pathogens per diagnosis of patients with Pediatric orthopeadics infections in HFCSUH, Harar, Ethiopia from January /2022 – December 2024.*

Diagnosis	Commonly Isolated microorganism	Frequency (N)	Percentage (%)
Chronic Osteomyelitis	**Staphylococcus aureus**	**24**	**51.1 %**
(n=47)	*MRSA*	*20*	*83.3 %*
	Not specified	*4*	*16.7 %*
	Gram Negative bacilli	**15**	**31.9 %**
	Enterobacter specious (including ESBL-producing)	*7*	*46.7%*
	Klebsiella specious	*5*	*33.3%*
	Pseudomonas Aeruginosa	*2*	*13.3%*
		1	

	Escherichia Coli	**4**		*6.7%*
	Enterococcus Specious	**4**	**8.5 %**	
	Coagulase Negative Staphylococcus		**8.5 %**	
Septic Arthritis *(n=27)*	**Staphylococcus Aureus**	**19**	**70.4%**	
	MRSA	*12*		*63.2 %*
	MSSA	*7*		*36.8 %*
	Coagulase Negative Staphylococcus	**3**	**11.1%**	
	Gram Negative bacilli	**3**	**11.1%**	
	Enterobacter specious (including ESBL-producing)	*2*		*66.7%*
	Pseudomonas Aeruginosa	*1*		*33.3%*
	Streptococcus Specious	**2**	**7.4%**	
Acute Osteomyelitis *(n=17)*	**Streptococcus Specious**	**8**	**47.1 %**	
	Staphylococcus Aureus	**5**	**29.4 %**	
	MRSA	*4*		*80.0 %*
	MSSA	*1*		*20.0%*
	Coagulase Negative Staphylococcus	**1**	**5.9%**	
	Gram Negative bacilli	**3**	**17.7%**	
	Citrobacter specious	*1*		*33.3%*
	Klebsiella Specious	*1*		*33.3%*
	E. coli	*1*		*33.3%*
Pyomyositis	**Streptococcus Specious**	**4**	**50.0 %**	
	Staphylococcus Aureus	**2**	**25.0 %**	
	MSSA	*1*		*50.0%*
	Coagulase Negative Staphylococcus	**1**	**12.5%**	
	Gram Negative bacilli (Unspecified)	**1**	**12.5%**	

Fracture-related Infection	**Klebsiella Specious**	**3**	**33.3 %**
	Staphylococcus Aureus	**2**	**22.2 %**
	Coagulase Negative Staphylococcus	**2**	**22.2%**
	Pseudomonas Aeruginosa	**1**	**11.1%**
	Enterobacter specious	**1**	**11.1%**
Necrotizing Fasciitis	**Klebsiella Specious**	**2**	**22.2 %**
	Pseudomonas Aeruginosa	**2**	**22.2 %**
	Proteus Specious	**2**	**22.2 %**
	Enterobacter specious	**1**	**11.1 %**
	Gram Negative bacilli (Unspecified)	**1**	**11.1 %**
	Streptococcus Specious	**1**	**11.1 %**

Abbreviation: ESBL- Extended Spectrum Beta-Lactamase; MRSA- Methicillin Resistant Staphylococcus Aureus Abbreviation: MSSA- Methicillin Sensitive Staphylococcus Aureus

Of the total patients with chronic osteomyelitis, 82 patients (90.1%) had culture results of which 37 patients (45.2%) had No growth, 43 patients (52.4%) exhibited a monomicrobial growth and 2 patients (2.4%) showed a polymicrobial bacterial growth. 47 isolates were identified from 45 culture positive cases. For patients with Septic arthritis, 44 patients (86.3%) had culture results of which 17 patients (38.6%) had No growth, 27 patients (61.4%) exhibited a monomicrobial growth with no patients showing a polymicrobial bacterial growth. With respect to patients with acute osteomyelitis, 21 patients (63.6%) had culture result and among these, 4 patients (19.1%) had no growth, 17 patients (80.9%) showed a monomicrobial bacterial growth. None had polymicrobial bacterial growth (**Table 9**).

4.2.2 Antibiotic Susceptibility Pattern of Bacterial Isolates of Pediatrics Orthopedics Infection

Table 10- *Antibiotic sensitivity profile of commonly isolated pathogens of patients with Pediatric orthopeadics infections in HFCSUH, Harar, Ethiopia from January /2022 – December 2024*

Antibiotic	Staphylococcus Aures			Coagulase-negative Staphylococcus			Streptococcus species			Gram-negative bacilli**	
	Sen* .(%)	Res* (%)	ND (%)	Sen. (%)	Res (%).	ND* (%)	Sen. (%)	Res. (%)	ND. (%)	Sen. (%)	Res (%)
Amikacin	**56.9**	**20.0**	**23.1**	70,6	0.0	29.4	**88.2**	**5.9**	**5.9**	18-25	36-58
Ampicillin	**0.0**	**81.5**	**18.5**	0.0	41.2	58.8	**5.9**	**76.5**	**17.6**	0-5	80-100
Augmentin	**10.8**	**46.2**	**43.1**	41.2	11.8	47.1	**41.2**	**0.0**	**58.8**	-	-
Cefazoline	**4.6**	**44.6**	**50.8**	11.8	29.4	58.8	**23.5**	**5.9**	**70.6**	0-9	25-67
Cefipime	**83.1**	**6.2**	**10.8**	76.5	0,0	23.5	**88.2**	**5.9**	**5.9**	41-100	0-50
Ceftazidime	**26.2**	**38.5**	**35.3**	52.9	0.0	47.1	**64.7**	**11.8**	**23.5**	33-66	18-50
Ceftriaxone	**12.3**	**69.2**	**18.5**	76.5	5.9	17.6	**70.6**	**5.9**	**23.5**	8-27	66-83
Ciprofloxacin	**72.3**	**12.3**	**15.4**	64.7	11,8	23.5	**23.5**	**41.2**	**35.3**	50-63	17-33
Clindamycin	**83.1**	**7.7**	**9.2**	58.8	0	41.2	**58.8**	**5.9**	**35.3**	0-25	18-66
Cotrimoxazole	**61.5**	**24.6**	**13.9**	58.8	5.9	35.3	**29.4**	**29.4**	**41.2**	25-45	33-36
Gentamicin	**81.5**	**6.2**	**12.3**	58.8	5.9	35.3	**70.6**	**17.6**	**11.8**	18-42	33-55
Meropenem	**69.2**	**3.1**	**27.7**	47.1	0	52.9	**58.8**	**0.0**	**41.2**	33-67	0-25
Oxacillin	**18.5**	**72.3**	**9.2**	41.2	11.8	47.1	**23.5**	**29.4**	**47.1**	0.0	80-100
Vancomycin	**89.2**	**1.5**	**9.2**	-	-	-	**64.7**	**0.0**	**35.3**	-	-

Abbreviation: * Sen- Sensitivity, Res- Resistance, ND- Not Done (Percentage)

**- Gram Negative bacilli- Includes Klebsiella, Enterobacteriaceae, Proteus, Pseudomonas Aeruginosa, Escherichia Coli and other unspecified one

Out of 65 isolates of Staphylococcus aureus, methicillin resistance was predominant, with 72.3% identified as MRSA as confirmed by oxacillin resistance (72.3%). Ampicillin resistance was also very high (81.5%). Sensitivity was retained to gentamicin (81.5%), clindamycin (83.1%), and

Vancomycin (>90%). Moderate sensitivity was observed to ciprofloxacin (63.2%) and Cotrimoxazole (61.5%). Resistance to Ceftriaxone (69.2%) and Augmentin (46.2%) was notable.

Seventeen isolates of Coagulase-negative Staphylococcus were identified. Resistance to ampicillin was 41.2%, while oxacillin resistance was lower (11.8%). Sensitivity was high to Gentamicin (58.8%), Clindamycin (58.8%), and Vancomycin (>90%). Ciprofloxacin and Cotrimoxazole retained moderate activity.

Seventeen isolates of Streptococcus species were recovered. Sensitivity was high to Amikacin (88.2%), ceftriaxone (70.6%), Ceftazidime (64.7%), and Vancomycin (>90%). Resistance was moderate to oxacillin (29.4%) and cotrimoxazole (29.4%).

For gram-negative bacilli (Enterobacteriaceae, Klebsiella, E. coli, Pseudomonas...), Resistance was consistently high to ampicillin (>80%), ceftriaxone (66–83%), and oxacillin (near 100%). Meropenem retained strong activity (61.8% sensitive overall), while aminoglycosides (Amikacin, Gentamicin) showed moderate effectiveness. Ciprofloxacin sensitivity was preserved in 63.2% of isolates (**Table 10**).

4.3 Management Strategies of Pediatric Orthopedic Infections

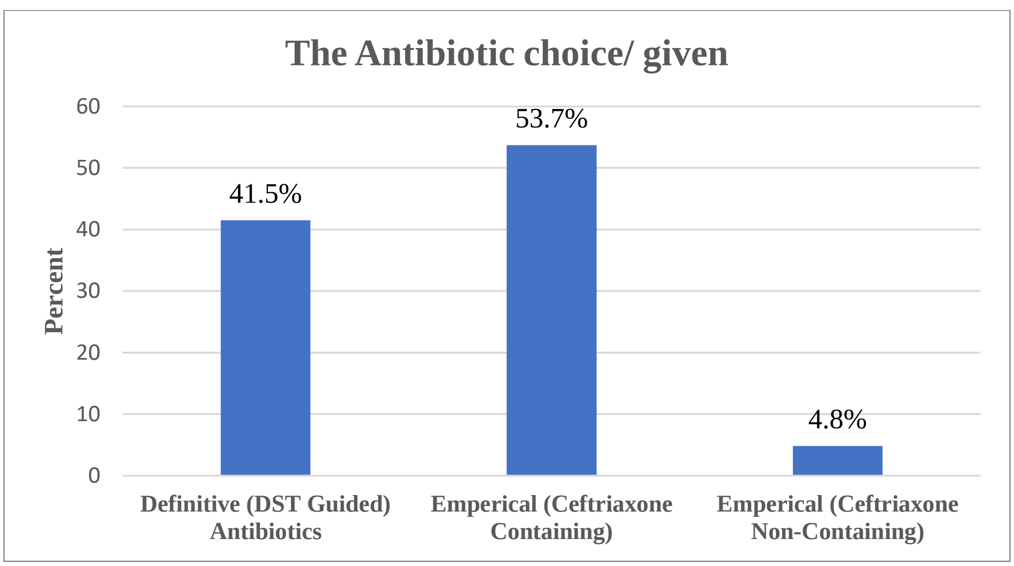


Figure 8*: The Antibiotic form and choice in the management of orthopeadics infection of pediatric patients from January, 2022- December, 2024 (n=311).*

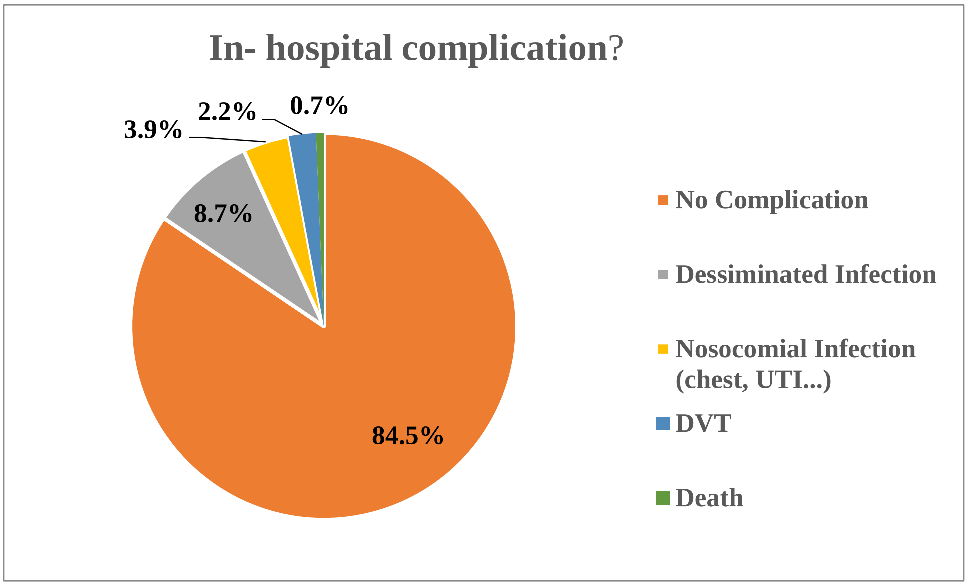
Out of 311 cases, 302 (97.1%) underwent both surgical intervention and antibiotic therapy, while only 9 patients (2.9%) were managed with antibiotics alone including 2 patients managed as an outpatient. Antibiotic therapy was universally applied, with a distinction between empirical and definitive (culture-guided) regimens. Empirical antibiotics were administered in 182 cases (58.5%), while definitive therapy guided by drug susceptibility testing was used in 129 cases (41.5%). Notably, ceftriaxone-containing empirical regimens were the most frequently prescribed, accounting for 167 cases (91.8%), whereas non-ceftriaxone empirical regimens were rare (8.2%) (**Figure 8**8).

With regard to the surgical procedure, 302 patients (97.1%) received some form of surgical intervention. 211 (69.9%) of the procedures were done in an emergency basis and 91 (30.1%) as an elective procedure. Incision or drainage (or Debridement and irrigation) is the commonest surgical procedure done (123 cases, 40.7%), followed by arthrotomy (70 cases, 23.1%) and Sequestrectomy (66 cases, 21.9%). 4 patients (1.3%) undergoes amputation as a primary treatment of the infectious process.

For patients who underwent surgical intervention as an emergency, the time from presentation to the first procedure varied widely. The mean interval was 13.73 hours (95% CI: 11.4–16.1), while the median was 8 hours with IQR of 6-12 hrs. The shortest time recorded was 4 hours, whereas the longest delay extended to 120 hours. Taking 6 hours after presentation as a cutoff, 152 (72.0%) of patients managed as an emergency had delay in getting their first surgical care.

4.4 Clinical Outcome and Factor Determining the Clinical Outcomes of Pediatric Orthopedic Infections

4.4.1 Clinical Outcomes of pediatric Orthopeadics Infections



Abbreviation: DVT- Deep Vein Thrombosis

Figure 09*- The in-hospital complication distribution of pediatrics patients admitted for orthopeadics infection from January, 2022- December, 2024.*

Of the total of 309 patients (99.3% of the sample) received an inpatient treatment, 48 patients (15.5%) had in-hospital complication including death in 2 patients (0.7%) (**Figure 09).** The average hospital stay was 16.1 days (95% CI: 15.1–17.2), with a median of 14 days. The duration ranged from 3 to 61 days, with an interquartile range of 9 days.

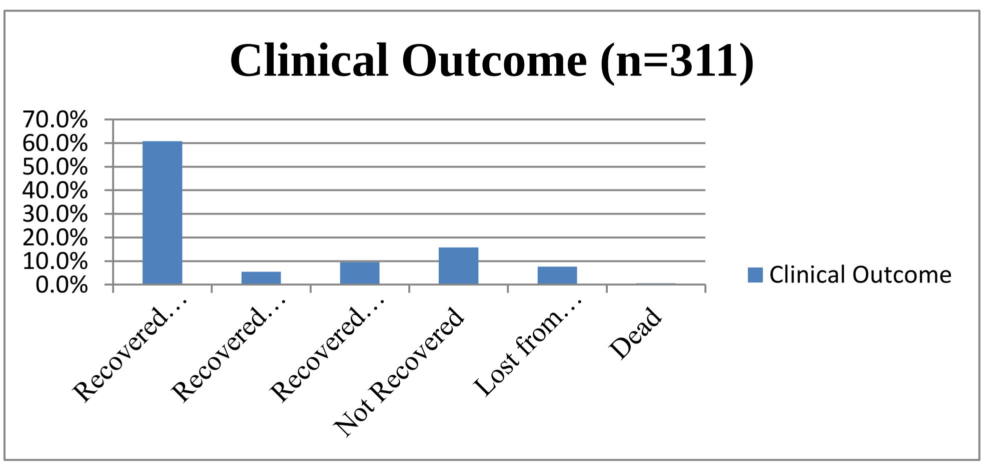


Figure 10*-The overall clinical outcome of pediatrics patients followed for orthopeadics infection from January, 2022- December, 2024.*

Out of 311 pediatric patients with orthopedic infections, the majority achieved favorable outcomes. **Complete recovery without complication** was documented in 189 cases (60.8%), representing the largest group. A smaller proportion, 17 patients (5.5%), recovered with minor residual complications (mild joint stiffness treated with home physiotherapy), while 30 patients (9.6%) recovered but were left with major residual complications, including contracture of a joint requiring formal physiotherapy (14 cases; 46.7%), bone gap requiring intervention (9 cases; 30.0%), leg length discrepancy (5 cases; 16.7%) and pathologic fracture (2; 6.7%).However, **complicated or unresolved infections** were noted in 49 patients (15.8%). Additionally, 24 patients (7.7%) were lost to follow-up, limiting the ability to fully assess their outcomes. Mortality was rare, with only 2 deaths (0.6%) recorded (**Figure 0**).

4.4.2 Factors determining the clinical outcomes of Pediatrics Orthopedic Infections

Table 11- *Factors determining poor clinical outcomes of pediatric orthopeadics infections in HFCSUH, Harar, Ethiopia from January /2022 – December 2024.*

Variables	Category	Treatment Outcomes		Bivariable Analysis		Multivariable Analysis	
		Good (206)	Poor (105)	COR (95% CI)	P-value	AOR (95% CI)	P-value
Sex	**Female ®** **Male**	57 (65.5) 149 (66.5)	30 (34.5) 75 (33.5)	**0.956** **(0.567-1.612)**	0.867	-	-
Residence	**Rural ®** **Urban**	150 (67.3) 56 (63.6)	73 (32.7) 32 (36.4)	**1.174** **(0.700-1.968)**	0.542	-	-
Antibiotics given	**Definitive ®** **Empirical**	82 (63.6) 124 (68.1)	47 (36.4) 58 (31.9)	**0.816** **(0.507-1.312)**	0.402	-	-
Late Presentation	**No ®** **Yes**	85 (76.6) 121 (60.5)	26 (23.4) 79 (39.5)	**2.135** **(1.266-3.597)**	**0.004***	**2.410** **(1.242-4.673)**	0.009*
Multifocal Involvement	**No®** **Yes**	183 (70.1) 23 (46.0)	78 (29.9) 27 (54.0)	**2.754** **(1.488-5.102)**	**<0.001 ***	**2.695** **(1.330-5.495)**	0.006*
Prior Antibiotic Exposure	**No®** **Yes**	138 (73.8) 68 (54.8)	49 (26.2) 56 (45.2)	**2.319** **(1.435-3.745)**	**<0.001 ***	**2.747** **(1.539-4.902)**	<0.001*

Continued

Variables	Category	Treatment Outcomes		Univariate Analysis		Multivariate Analysis	
		Good (206)	Poor (105)	COR (95% CI)	P-value	AOR (95% CI)	P-value
Malnutrition	**No®** **Yes**	179 (72.5) 27 (42.2)	68 (27.5) 37 (57.8)	**3.607** **(2.041-6.369)**	**<0.001***	**2.451** **(1.255-4.785)**	**0.009***
Anemia at Presentation	**No®** **Yes**	107 (78.1) 99 (56.9)	30 (21.9) 75 (43.1)	**2.702** **(1.631-4.464)**	**<0.01***	**1.639** **(0.905-2.967)**	**0.103**
MRSA	**No ®** **Yes**	186 (69.9) 20 (44.6)	80 (30.1) 25 (55.6)	**2.906** **(1.527-5.525)**	**0.001***	**3.268** **(1.560-6.849)**	**0.02***
Delay in Surgical care of emergency (>6hrs.)	**No®** **Yes**	114 (76.0) 92 (60.5)	36 (24.0) 60 (39.5)	**2.065** **(1.258-3.390)**	**0.004***	**1.815** **(1.013-3.247)**	**0.045***
Both Medical and surgical Rx.^	**Yes®** **No**	206 (68.2) 0 (0.0)	96 (31.8) 9 (100)	**3.146** **(2.667-3.711)**	**<0.001*** **(Exact Sig. 2-sided)**		

Note: *Statistically significant association, ^- unfit for multivariate logistic regression, ®- Reference group

Abbreviation: MRSA- Methicillin Resistant staphylococcus aureus

5. DISCUSSION

5.1 Prevalence and Demographic Characteristics

The study finds that pediatric orthopedic infections accounted for 32.1% of all pediatric orthopedic visits during the study period. This high prevalence is consistent with reports from other low- and middle-income countries (LMICs), where musculoskeletal infections represent a substantial burden on healthcare systems (Adam M. Ali, 2014; Schwend, 2020). The figure is considerably higher than the 10% of outpatient visits for osteomyelitis reported in Uganda (Stanley et al., 2010) but lower than the 86.3% prevalence of chronic osteomyelitis specifically reported from Felege Hiwot Comprehensive Specialized Hospital in Northwest Ethiopia (Mulualem et al., 2023). This variation likely reflects differences in study populations, referral patterns, and healthcare-seeking behaviors across regions.

The male predominance (72.0%) observed in this study aligns with multiple studies from Ethiopia and elsewhere in sub-Saharan Africa (Gizaw et al., 2025; Mamo et al., 2021; Mulualem et al., 2023). Mamo et al. reported 70% male predominance in Jimma (Mamo et al., 2021), while Mulualem et al. found males were six times more likely to develop chronic osteomyelitis (Mulualem et al., 2023). This consistent finding may be explained by gender-related differences in outdoor activities, trauma exposure, and possibly healthcare-seeking patterns, though further research is needed to elucidate the underlying mechanisms.

The mean age of 11.2 years and the predominance of older children (44.1% in the 12-18 years age group) differ somewhat from studies in high-income countries where younger children are more commonly affected (Trobisch et al., 2022; Yi et al., 2021). This age distribution may reflect delayed presentation and progression to chronic disease in our setting, as evidenced by the high proportion of chronic osteomyelitis cases (29.3%) and the mean age of 11.7 years among chronic osteomyelitis patients.

The rural predominance (71.7%) is striking and consistent with findings from Mulualem et al., who reported that rural residents had four times higher odds of poor outcomes (Mulualem et al., 2023). This urban-rural disparity likely reflects multiple factors including limited access to primary healthcare, greater exposure to agricultural or farm injuries, lower health literacy, and higher rates of traditional healer consultation (28.0% in my study), all contributing to delayed presentation and more advanced disease at diagnosis.

5.2 Types of Infections and Clinical Presentation

Chronic osteomyelitis was the most frequent diagnosis (29.3%), followed by septic arthritis (16.4%) and acute osteomyelitis (10.6%). The predominance of chronic disease is concerning and reflects the significant delays in diagnosis and treatment that characterize resource-limited settings (Olivier et al., 2019). The tibia (35.2%), femur (27.5%), and humerus (12.1%) were the most commonly involved bones in chronic osteomyelitis, consistent with the hematogeneous spread pattern typical of pediatric osteomyelitis (Dartnell et al., 2012). The majority of chronic osteomyelitis cases (62.6%) were classified as Cierny-Mader Type III, indicating localized, well-contained lesions with sequestration but without significant stability compromise, which is amenable to less invasive and less costly surgical intervention when timely care is accessible.

Septic arthritis accounted for 16.4% of cases, with the knee joint most frequently involved (56.9%), followed by the hip (17.6%) and elbow (11.8%). Small cohorts are found in the shoulder and ankle joint (7.9% and 5.9% respectively). This joint distribution is consistent with published literature; a recent multicenter study of pediatric septic arthritis found that among 684 patients, only 12% involved the foot and/or ankle, while the knee, hip and elbow joints accounts for greater than 75% together (Stepanovich et al., 2025). The mean age of children with septic arthritis in this cohort was 11.1 years, which is older than the median age of 7.0 years reported by Stepanovich et al. (Stepanovich et al., 2025) and substantially older than the infant predominance described for Streptococcus pneumoniae arthritis (Li et al., 2025). This age distribution may reflect the high proportion of S. aureus infections (45.1% of grown bacterial specious in culture-positive cases) in our cohort, as S. aureus septic arthritis tends to affect older children compared to pneumococcal disease (Li et al., 2025). The male predominance (64.7%) aligns with the 56% male proportion reported in the multicenter study (Stepanovich et al., 2025).

Acute osteomyelitis comprised 10.6% of cases, with a mean age of 7.8 years—comparable to the median age of 8.4 years reported in a large US pediatric emergency department study (Stephan et al., 2022). The tibia (57.6%) and femur (30.3%) were predominantly involved. The clinical presentation in this study aligns with published data: pain was nearly universal, and fever was also documented in 84.8% of patients with acute osteomyelitis. Stephan et al. found that 76.3% of children with acute osteomyelitis presented with fever, and 23.7% were afebrile (Stephan et al., 2022). Bueno Barriocanal et al. reported fever in 72% of their acute osteomyelitis cases (Bueno Barriocanal et al., 2013).

Importantly, combined infections (acute or chronic osteomyelitis with concurrent septic arthritis) were documented in 19 patients (6.1%). This figure is lower than the 29.9% prevalence of coexisting osteomyelitis reported by Favre et al. in a Swiss cohort (Favre et al., 2025), but the difference likely reflects the lack of routine MRI in our setting, which would detect more cases of concurrent bone involvement. As Favre and colleagues demonstrated, among children with septic arthritis and coexisting osteomyelitis, 51% had acute and 49% had sub-acute bone infection, with metaphyseal involvement most common (39.6%) (Favre et al., 2025). The under-diagnosis of combined infections in resource-limited settings has clinical significance, as these patients may require longer antibiotic courses and more aggressive surgical intervention (Siddiqui et al., 2021).

Pyomyositis was diagnosed in 22 patients (7.1%), while necrotizing fasciitis comprised 20 cases (6.4%). These severe soft tissue infections are relatively uncommon in pediatric populations but carry high morbidity. Tanir et al., in a retrospective analysis of 242 hospitalized children with soft tissue infections, found pyomyositis in only 2.5% and necrotizing fasciitis in 1.6% (Tanir et al., 2006). The higher proportions in our cohort likely reflect selection bias at a tertiary referral center, where only the most severe cases present. Pyomyositis, traditionally considered a tropical disease, can occur in temperate climates and is often caused by S. aureus (Verma, 2016). The high proportion of Gram-negative organisms in our necrotizing fasciitis cases (Klebsiella, Pseudomonas, and Proteus) is notable and may reflect environmental contamination of wounds or healthcare-associated infections.

Other soft tissue infections, including abscess collections, accounted for 51 cases (16.4%). In the Tanir series, soft tissue infections were distributed as cellulitis (39.7%), lymphadenitis (25.6%), cervical abscess (20.2%), and subcutaneous abscess (10.3%) (Tanir et al., 2006). While our study did not sub-classify these infections in detail, their inclusion reflects the full spectrum of pediatric musculoskeletal infections presenting to a tertiary hospital in a resource-limited setting.

The lower extremity predominance (82.6%) across all infection types is consistent with global literature and reflects the increased vulnerability of weight-bearing bones to trauma and hematogeneous seeding (Gigante et al., 2019). The high proportion of traumatic mode of onset (46.3%), with falls (31.9%) and road traffic accidents (20.8%) being the most common mechanisms, highlights the important role of trauma as a portal of entry or predisposing factor for infection in this population. This association between trauma and subsequent infection has been recognized for decades, with disruption of vascular supply and formation of hematoma creating a favorable environment for bacterial seeding (Lew & Waldvogel, 2004).

When considering the clinical presentation in general along all the study participants, Pain was nearly universal (98.7%), while fever was documented in only 50.2% of patients. The absence of fever in half the cases, particularly in chronic infections, underscores the diagnostic challenge in resource-limited settings where advanced imaging may not be readily available. This finding aligns with reports that fever may be absent in up to 40% of children with osteomyelitis, especially in sub-acute or chronic presentations (Peltola & Paakkonen, 2014). The high prevalence of anemia at presentation (56% overall, with 27% moderate and 3.2% severe anemia) likely reflects the combined effects of chronic inflammation, malnutrition, and possibly hemolysis in infections such as malaria-endemic regions. The 91.6% rate of elevated ESR and 66.2% rate of elevated CRP are consistent with the high sensitivity of these markers reported by Stephan et al. (94.3% and 92.9%, respectively) (Stephan et al., 2022).

Late presentation (>7 days of symptoms onset) was documented in 64.3% of patients, and 28.0% had consulted traditional healers before presenting to hospital. These findings are consistent with studies from Tanzania and Uganda, where cultural beliefs, geographic barriers, and limited access to formal healthcare contribute to delayed presentation (Adam M. Ali, 2014; Loro et al., 2023). The combination of traditional healer consultation and late presentation creates a vicious cycle where patients present with more advanced disease requiring more complex interventions and associated with poorer outcomes.

5.3 Microbiological Profile and Antibiotic Resistance Pattern

The culture positivity rate of 58.0% (134/231 cultured cases) is comparable to rates reported from other Ethiopian studies (58.8% in Jimma (Gizaw et al., 2025)) but lower than rates in high-income countries where molecular diagnostics are more readily available (Ceroni et al., 2014). The high proportion of culture-negative cases (42.0%) likely reflects several factors: high rates of pre-admission antibiotic use (39.9% in this study), limitations in the microbiology laboratory capacity for fastidious organisms such as Kingella kingae, and possible suboptimal specimen collection and transport (Yagupsky, 2012).

Staphylococcus aureus was the predominant pathogen (45.1% of isolates), consistent with global and regional literature (Alelign et al., 2022; Gizaw et al., 2025; Liu et al., 2011; Mamo et al., 2021). The MRSA rate of 72.3% among S. aureus isolates is alarmingly high and exceeds rates reported from most Ethiopian studies. Gizaw et al. reported significant methicillin resistance among S. aureus isolates in Jimma (Gizaw et al., 2025), while Tadesse et al. documented high resistance to commonly used antibiotics in Addis Ababa (Tadesse et al., 2018). Our MRSA rate is substantially higher than the 24.5% reported from a multicenter European study (Trobisch et al., 2022) and even exceeds rates from some North American centers where MRSA is considered endemic (Turner et al., 2019). This finding has profound implications for empirical antibiotic selection.

The resistance pattern observed is deeply concerning. Ceftriaxone, the most commonly used empirical antibiotic (91.8% of empirical regimens), showed poor activity against S. aureus (only 12.3% sensitive), with 69.2% of isolates resistant. This suggests that the current empirical antibiotic strategy may be inadequate for a large proportion of patients. Ampicillin resistance was near-universal among Gram-negative isolates (80-100%) and very high among S. aureus (81.5%), rendering this antibiotic essentially useless for empirical therapy.

Encouragingly, several antibiotics retained good activity. Vancomycin remained effective against >90% of S. aureus isolates, clindamycin showed 83.1% sensitivity, and gentamicin retained 81.5% activity. Among Gram-negative organisms, Meropenem (61.8% sensitive overall) and Amikacin showed reasonable activity, though resistance was not negligible. The moderate sensitivity to ciprofloxacin (63.2% overall) offers some oral options for step-down therapy, though resistance rates of 12.3-41.2% across organism groups warrant caution.

The differential distribution of pathogens by diagnosis provides clinically useful insights. In acute osteomyelitis, Streptococcus species (47.1%) including group A streptococcus, were more common than S. aureus (29.4%), possibly reflecting the younger age distribution (mean 7.8 years) and the importance of respiratory pathogens in this age group (Ceroni et al., 2014). In septic arthritis, S. aureus predominated (70.4%) with a 63.2% MRSA rate, while in chronic osteomyelitis, S. aureus (53.3%) with 83.3% MRSA was dominant, followed by diverse Gram-negative organisms (33.3%) including coagulase negative staphylococcus such as staphylococcus Epidermidis and Staphylococcus Lugdunensis. The prominence of Gram-negative organisms in chronic osteomyelitis and fracture-related infections (Klebsiella specious including K. Pneumoniae, k. Oxytoca, K. Rhinoscler, K. Ozane, as well as Pseudomonas Aeruginosa and, Enterobacter (E. Clocae and E. Cancerogenus) likely reflects the role of environmental contamination in traumatic wounds and healthcare-associated infections (Horn et al., 2024).

5.4 Management Strategies

The finding that 97.1% of patients received combined surgical and medical therapy reflects the standard of care for established orthopedic infections and the advanced stage of disease at presentation(Belthur, 2022). However, the fact that only 41.5% received culture-guided (definitive) antibiotic therapy, while 58.5% were managed with empirical antibiotics alone, represents a significant gap in quality of care. This likely reflects failure to send sample for microbiological analysis, sending poor quality or a single specimen, limited access to microbiology services (during the study period), delays in obtaining results, or failure to adjust therapy when results become available—all common challenges in resource-limited settings (Adam M. Ali, 2014).

The predominance of ceftriaxone-based empirical regimens (91.8%) is concerning given the resistance data presented above. The very low sensitivity of S. aureus (12.3%) and moderate sensitivity of Gram-negative organisms (8-27%) to ceftriaxone suggest that many patients received inadequate empirical coverage especially if the ceftriaxone is used as a monotherapy. This mismatch between empirical practice and susceptibility patterns may contribute to the high rates of poor outcomes observed and underscores the urgent need for updated local treatment guidelines.

The timing of surgical intervention reveals important quality gaps. Among patients requiring emergency surgery, the median time to procedure was 8 hours, with 72.0% experiencing delays beyond the 6-hour benchmark recommended for optimal outcomes (Yi et al., 2021). Delays ranged up to 120 hours, reflecting systemic challenges including patient being unfit for surgery or anesthesia for other medical reasons like anemia or concomitant severe infection to the chest, inability to get timely consent for surgery from the family or guardian, and financial constraints. These delays have documented consequences for outcomes, as demonstrated in our regression analysis. The spectrum of surgical procedures—predominantly incision and drainage/debridement (40.7%), arthrotomy (23.1%), and Sequestrectomy (21.9%)—reflects the case mix of acute and chronic infections. The 1.3% amputation rate, while seemingly low, represents devastating outcomes for affected children and their families, highlighting the severe end of the disease spectrum.

5.5 Clinical Outcomes and Associated Factors

The overall outcomes in this study are concerning. While 60.8% of patients achieved complete recovery without complications and 5.5% of patients recovered with a minor complication, a substantial proportion experienced poor outcomes (33.7%) : 15.8% had unresolved infections, 9.6% recovered with residual major complications, 7.7% were lost to follow-up and 0.6% were dead. The in-hospital complication rate of 16.2% and mortality of 0.6 % are comparable to reports from similar settings (Mamo et al., 2021; Robertson et al., 2012) but higher than in high-income countries where mortality from pediatric osteomyelitis is now exceptional(Arnold & Bradley, 2015).

The mean hospital stay of 16.1 days (median 14 days) is longer than the 10-12 days typically reported in high-income settings (Dhar et al., 2020) but shorter than the 65 weeks reported for complicated cases in some LMIC studies (Horn et al., 2019), reflecting the variability in disease severity and healthcare systems.

The multivariable logistic regression analysis identified several independent predictors of poor outcome, providing actionable targets for intervention:

Late presentation (>7 days of symptoms) more than doubled the odds of poor outcome (AOR: 2.41; 95% CI: 1.24-4.67; p=0.009). This finding is consistent with multiple studies demonstrating that delayed diagnosis and treatment are associated with higher rates of chronic infection, growth disturbances, and long-term functional impairment (Ceroni et al., 2014; Ju et al., 2011; Yi et al., 2021). The mechanisms are straightforward: delayed treatment allows infection to progress, causing more extensive tissue destruction, and makes eradication more difficult. This finding underscores the critical importance of community education to promote early care-seeking and of primary healthcare strengthening to enable prompt diagnosis and referral.

Multifocal involvement was associated with nearly threefold increased odds of poor outcome (AOR: 2.70; 95% CI: 1.33-5.50; p=0.006). Multifocal disease reflects hematogeneous seeding and often indicates more severe systemic illness, greater difficulty in achieving source control, and higher likelihood of complications (McNeil, 2020). This finding highlights the need for more aggressive management and closer monitoring of children with multifocal infections.

Prior antibiotic exposure before hospital admission nearly tripled the odds of poor outcome (AOR: 2.75; 95% CI: 1.54-4.90; $p<0.001$). This association likely operates through multiple mechanisms: inappropriate or inadequate prior antibiotics may partially suppress but not eradicate infection, leading to delayed presentation with more advanced disease; they may select for resistant organisms; and they may render subsequent cultures negative, forcing continued empirical therapy without microbiological guidance (Belthur, 2022; Yagupsky, 2012). This finding highlights the dangers of indiscriminate antibiotic use in the community and the importance of rational antibiotic prescribing.

Malnutrition more than doubled the odds of poor outcome (AOR: 2.45; 95% CI: 1.26-4.79; $p=0.009$). The biological plausibility is strong: malnutrition impairs cell-mediated immunity, reduces phagocytic function, compromises wound healing, and may alter antibiotic pharmacokinetics (Bourke et al., 2016). This finding aligns with studies from sub-Saharan Africa documenting worse outcomes in malnourished children with infections (Nunn et al., 2007; Robertson et al., 2012) and underscores the need for integrated nutritional support as part of comprehensive infection management.

MRSA infection was associated with more than threefold increased odds of poor outcome (AOR: 3.27; 95% CI: 1.56-6.85; $p=0.02$). This finding corroborates extensive literature documenting that MRSA infections cause more severe disease, require more complex management, and are associated with higher complication rates compared to methicillin-sensitive strains (Chen et al., 2025; Liu et al., 2024; Turner et al., 2019). The high prevalence of MRSA in our setting (72.3%) makes this a particularly urgent problem.

Delay in emergency surgical care *(>6 hours)* nearly doubled the odds of poor outcome (AOR: 1.82; 95% CI: 1.01-3.25; $p=0.045$). This finding adds to the evidence supporting timely surgical intervention for source control in orthopedic infections (Iliadis & Ramachandran, 2017; Yi et al., 2021). Each hour of delay potentially allows infection to propagate, increasing tissue destruction and making subsequent eradication more difficult. This finding highlights systemic bottlenecks in surgical care delivery that require health system-level interventions.

Notably, **combined medical and surgical therapy** was universally associated with good outcomes—all 9 patients managed with antibiotics alone (without surgery) had poor outcomes, though the small number precluded inclusion in multivariate analysis. This finding, while expected, reinforces the importance of surgical source control in managing established orthopedic infections (Belthur, 2022; Gornitzky et al., 2020).

Interestingly, **sex, residence and antibiotic choice** were not associated with outcome in the bivariate analysis and so the adjusted model, despite the findings from other studies (Mulualem et al., 2023). This suggests that the effects of the demographic factors are mainly mediated through the clinical variables included in the model (delayed presentation, malnutrition, etc.), rather than operating independently. Regarding the antibiotics choice, possible explanation for not being significant includes surgical source control may outweigh antibiotic choice as 97.1% had surgery (Belthur, 2022; Gornitzky et al., 2020). Other possible explanations include delayed switch to definitive therapy, which impacts the possible improved outcome from definitive antibiotics (Adam Ali et al., 2014) and confounding by severity, which means sickest patient more likely to get cultures and definitive therapy. It should not be interpreted as if antibiotic choice does not affect outcomes, rather our current antibiotic practices-both empirical and definitive- are inadequate to overcome the powerful negative effects of delayed presentation, surgical delay, malnutrition and MRSA.

5.6 Study Strengths and Limitations

5.6.1 Strengths

This study has several important strengths. It is one of the largest and most comprehensive analyses of pediatric orthopedic infections in Eastern Ethiopia, providing robust data on prevalence, microbiology, management, and outcomes. The sample size of 311 patients with a 95.4% response rate provides sufficient statistical power for multivariable analysis. The inclusion of detailed microbiological and susceptibility data allows evidence-based recommendations for empirical therapy. The use of multivariable logistic regression enables identification of independent predictors of outcome while controlling for confounders.

5.6.2 Limitations

Several limitations must be acknowledged when interpreting these findings. First, the retrospective design relying on medical records introduces potential for information bias and missing data. While we attempted to minimize this through rigorous data collection and a 10% contingency in sample size calculation, some variables (particularly laboratory parameters and long-term follow-up data) were incompletely documented. Second, the study was conducted at a single tertiary referral center, which may limit generalizability to primary or secondary care settings. Patients presenting to our hospital likely represent more severe or complicated cases (referral bias), potentially overestimating disease severity and poor outcomes. Third, the high rate of culture-negative cases (42.0%) and the absence of molecular diagnostic techniques (e.g., PCR for Kingella kingae) mean there may have been underestimation of the role of fastidious organisms. Fourth, loss to follow-up (7.7%) may have led to underestimation of long-term complication rates. Fifth, we were unable to assess certain potential confounders such as socioeconomic status and parental education level, which were not consistently recorded in charts. Finally, the relatively small number of patients in some diagnostic subgroups (e.g., TB arthritis, Myecetoma) limits subgroup analyses.

6. SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Conclusions

This study demonstrates that pediatric orthopedic infections at HFCSUH are characterized by high prevalence, advanced disease at presentation, alarming rates of antimicrobial resistance (particularly MRSA at 72.3%), and suboptimal clinical outcomes. Staphylococcus aureus remains the predominant pathogen, but the resistance profile renders current empirical therapy (ceftriaxone-based) inadequate for many patients. Late presentation, multifocal involvement, prior antibiotic exposure, malnutrition, MRSA infection, and delays in surgical care are independent predictors of poor outcome, while combined medical and surgical therapy is protective.

These findings highlight an urgent need for context-specific clinical guidelines that account for local resistance patterns, strengthened diagnostic capacity to enable culture-guided therapy, systems improvements to reduce delays in surgical care, and integrated nutritional support for affected children. Public health interventions aimed at promoting early care-seeking and addressing the social determinants of health that drive urban-rural disparities are also essential. Without such multifaceted interventions, the burden of pediatric orthopedic infections and their long-term consequences for children and families in Eastern Ethiopia will remain unacceptably high.

6.2 Recommendations

For clinicians at HFCSUH and similar settings:

The current empirical antibiotic strategy (ceftriaxone-based) appears inadequate given the high resistance rates documented. Based on our susceptibility data, we recommend considering alternative empirical regimens that provide coverage for MRSA (e.g., clindamycin or Vancomycin) while awaiting culture results, combined with agents active against Gram-negative organisms (e.g., gentamicin or Amikacin) for suspected chronic osteomyelitis or healthcare-associated infections. However, this must be balanced against the risks of broader empirical coverage and should be guided by local antibiotic stewardship principles. Crucially, every effort should be made to obtain cultures before initiating antibiotics to enable subsequent de-escalation.

The strong association between delayed surgical care and poor outcomes calls for systems improvements to ensure timely surgical intervention for children with orthopedic infections. This may require dedicated social worker system to address financial constraints, improving availability of important medications in the local pharmacy, community education on the disease process and the need for surgical intervention through different community outreaching programs, improving access to blood and blood products, improved triage systems, and protocols prioritizing these cases.

The high prevalence of malnutrition and its impact on outcomes underscores the need for integrated nutritional assessment and support as standard components of care for children with orthopedic infections.

For hospital administrators and policymakers:

The findings justify investment in strengthening microbiology laboratory capacity, including the ability to perform and rapidly report culture and sensitivity testing. This is essential for enabling culture-guided therapy and combating antimicrobial resistance.

The urban-rural disparities in disease burden and outcomes call for interventions at multiple levels: community health education to promote early recognition and care-seeking, strengthening of primary healthcare facilities to enable prompt diagnosis and referral, and addressing barriers to accessing surgical care for rural populations.

The high MRSA rates highlight the need for strengthened infection prevention and control programs within healthcare facilities and antimicrobial stewardship initiatives in the community.

For future research:

Prospective multicenter studies with standardized data collection and long-term follow-up are needed to better understand the full burden of disease and to evaluate the impact of new treatment protocols. Research should also explore the role of molecular diagnostic techniques (e.g., PCR) in improving pathogen detection, particularly for fastidious organisms like Kingella kingae. Implementation research is needed to identify effective strategies for reducing delays in presentation and surgical care. Finally, cost-effectiveness studies of different empirical antibiotic strategies would help guide resource allocation in this setting.

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8. APPENDICES

8.1. Participant information sheet and Informed Voluntary Consent for the head of Hiwot-Fana Comprehensive specialized University hospital

1. Introduction:

My name is Dr. Tesfahun Kebede; I am the Principal Investigator (PI) of the study to be conducted in HFCSUH Orthopeadics and pediatrics department. I am studying for my specialty in Orthopeadics and trauma Surgery at Haramaya University, College of Health and Medical Sciences. I kindly request you to lend me your attention to explain you about the study that will be conducted in this Hospital

2. The study/project title:

Retrospective Cross-sectional study on Pediatric Orthopedics Infections: Prevalence, Microbiology, Management, and Clinical Outcomes.

3. Purpose/aim of the study:

The purpose of this study is to understand the prevalence, Microbiological profile & their antibiotic sensitivity pattern of pediatric musculoskeletal infections as well as the management strategies being employed and the Clinical outcomes with their major determinants. The findings of this study can be of a paramount importance for the Hospital to plan intervention programs to address this common problem, thereby improve the overall outcome. Moreover, the aim of this study is to write a thesis as a partial requirement for the fulfillment of certificate of specialty in orthopeadics ad trauma Surgery Program for the principal investigator.

4. Procedure:

As the study is retrospective cross-sectional study, pertinent data that is helpful for the study will be collected from medical records and charts of included patients using structured questionnaire.

5. Risks and benefits:

There is no risk to be posed to the patient as the data will be collected from patient charts anonymously. There would not be direct benefit of patient for participating in this study. But conducting this study will help as to design strategies to know burden of the problem for the better outcome and as well the findings from this research may reveal important information for the local health planners.

6. Confidentiality:

All information collected will be kept confidential and used solely for research purposes. There will be no information that will identify the participant in particular. The findings of this study will be general for the study community and will not reflect anything particular of individual persons. The questionnaire will be coded to exclude showing names No reference will be made in oral or written reports that could link the participants to the research.

7. Rights:

As the head of the hospital, you have full right to permit or not to permit this research to be done in this hospital. If you decide to permit, the Hospital has also got the right to stop this study from being conducted if any misdeeds and unethical procedures are observed during the data collection process in the Hospital's premises without providing written or oral warning.

8. Contact address:

If there are any questions or enquires any time about the study or the procedures, please contact me by using my mobile phone number: +251-934131544/+251-706951544 or E-mail: bhope.tesf@gmail.com as well as contact address of the responsible Institutional Health Research Ethics Review Committee (IHRERC) at office phone 0254662011 or P.O.Box 235, Harar, Ethiopia.

9. Declaration of informed voluntary consent:

I have read the participant information sheet. I have clearly understood the purpose of the research, the procedures, the risks and benefits as well as the issues of confidentiality. The contact address was given to me for any queries. I have been given the opportunity to ask questions for things that may have been unclear. I am informed that the Hospital has the right to stop this study from being conducted if any misdeeds and unethical procedures are observed during the data collection process in the Hospital's premises. Therefore, I declare my voluntary consent on behalf of Hiwot-Fana Comprehensive Specialized University Hospital management (HFCSUH) to allow this study to be conducted in the Hospital with my initials (signature).

Name and Signature of Head of the Hospital: _____________________ Date ________

Name and Signature of the PI: ______________________________ Date ________

8.2. Data Collection Checklist

Retrospective Cross-sectional study on Pediatric Orthopedics Infections: Prevalence, Microbiology, Management, Clinical Outcomes and associated factors		
	Name of hospital	HFCSUH
	Name of the data collector	
	Date of data collection (dd/mm/yyyy)	
	Part I: Socio-Demographic data	
100.	Code	
101.	Age (years)	
102.	Sex	1. Male 2. Female
103.	Residence	1. Rural 2. Urban
	Part II General condition of the patients	
200	Involved bones (Affected area)	1. Tibia 2. Femur 3. Humerus 4. Calcaneus 5. Fibula 6. Other foot bones 7. Radius 8. Ulna 9. Hand bones 10. Ankle Joint 11. Knee joint 12. Hip joint 13. Shoulder joint 14. Elbow joint 15. Wrist joint 16. Others (specify)___________________
201	Mode of onset	1. Heamatogenous 2. Traumatic

		3. Contagious 4. Others specify_______________
202.	Mechanisms of injury/trauma (if Q201= 2)	1. FDA 2. RTA 3. Fracture 4. Bullet injury 5. Stick injury 6. Prick injury 7. Mencha injury 8. Others specify ______
203.	Total duration of the illness before presentation (in days)	
204	Went to Traditional Healers	
205.	**Presentation**	
205a	Discharge	1. Yes 0. No
205b	Swelling	1. Yes 0. No
205c	Pain	1. Yes 0. No
205d	Limitation of movement/function	1. Yes 0. No
205e	Limping	1. Yes 0. No
205f	Fever	1. Yes 0. No
205G	Loss Of Appetite	1. Yes 0. No
205h	Dark Discoloration	1. Yes 0. No
205i	Respiratory symptoms	1. Yes 0. No
205j	Exposed/ Necrotic bone	1. Yes 0. No
206.	Previously taken antibiotics (on the chart or referral paper)?	1. Yes 0. No
	Part III Related factors and laboratory findings	
300.	Malnutrition(Documented)	1. Yes 0. No
301.	Malnutrition (severity) if 300;is yes	0. Mild malnutrition 1. Moderate malnutrition 2. Severe malnutrition
302.	Diabetes mellitus	1. yes

		0. No
303.	HIV or other immune suppressive Conditions	1. Yes 0. No
304.	Orthopedic implant	1. Yes 0. No
305.	Malignancy	1, Yes 0, No
306.	CBC	1. WBC 2. Hemoglobin- 3. Platelet-
307.	ESR	
308.	CRP	
309.	X-ray finding	1.Sequestrum 2. Involcrum 3. Soft tissue swelling 4. Cloaca 5. Brodie's abscess 6. Periosteal reaction 7. Lytic destruction 8. other specify
310.	Ultrasound (for septic arthritis & pyomyositis)__	
311	Other Imaging studies (Specify)	
312.	Diagnosis of the patients	1. Acute Osteomyelitis 2. Chronic osteomyelitis 3. Septic arthritis 4. Pyomyositis 4. Combined infection 5. Necrotizing Fasciitis 6. other specify____
313.	Concurrent Infection? (different diagnosis at the same patient simultaneously)	1. Yes 2. No
314	Is culture result available?	0. No 1. Yes

315	Result Of the culture result?	0. No growth 1. Monomicrobial growth 2. Polymicrobial growth
316.	Culture , If 315; 1 or 2	1. Isolate I 2. Isolate II
317.	Antibiotics sensitivity, repeat if polymicrobial growth is observed	1. Ampicillin S ☐ R ☐ ND ☐ 2. Amikacin 3. Ampicillin-sublactam 4. Augmentin 5. Cefazoline 6. Ceftriaxone 7. Cefotaxime 8. Ceftazidime 9. Cefepime 10. Caf 11. Ciproflaxacin 12. Levofloxin 13. Cortimaxazole 14. Gentamycin 15. Meropenem 16. Imipenem 17. Piperacillin-tazobactam 18. Nitrofurontoin 19. Tetracycline 20. Erythromycin 21. Clindamycin 22. Azithromycin 23. Oxacillin 24. Penicillin 25. Vancomycin
	Part IV Inpatient management	
400	Medical Management	1. None 2. Empiric Antibiotic treatment a. Specific agents/s_______ b. Route(IV/PO/Iv then Po/IM)______ c. Duration 3. Definitive antibiotics therapy a. Specific agents/s_______ b. Route(IV/PO/ Iv then Po /IM)______ c. Duration

401	Total length of duration on Antibiotics (in days)	
402.	Route of the total antibiotic	1, Oral 2, IV 3, IM 4, IV then PO
403.	Surgical Management	1. No Surgery 2. Incision and Drainage (wash only) 3. Debridement and irrigation 4. Debridement and intramedullary reaming 5. Sequestrectomy 6. Others (Specify)
404.	Time from presentation to the first surgical management (in hours), if surgically managed (Q-403).	
405	In-hospital complication	0. No 1. Yes, 1. Sepsis (Disseminated infection) 2. Nosocomial infection 3. DVT 4.. Death 5. Others , Specify________
405.	Length of Hospital stay (in Days)	
	Part V Clinical outcome	
500	Resolution of clinical symptoms (fever, pain) on follow up	1. YES 2. NO 3. Unknown (lost or dead)
501.	Post-operational complication	0, No 1, Yes 2. Unknown (Lost/Dead)
502.	If yes, what complication?	1. Unresolved infection (progression) 2. pathologic Fracture 3. Leg length discrepancy

		4.contracture or stiffness of a joint (an degree) 5.Avascular necrosis 6. Ankylosis 7. Growth Disturbances 8. Re-infection 9. Unknown (lost from follow up) 10. Others (specify)____________
505.	Patient outcome	0. Not Recovered/Infection not controlled 1. Recovered (Infection controlled) without residual complication 2. Recovered (Infection controlled) with minor residual complication 3. Recovered (Infection controlled), but with major residual complication 4. Lost from follow-up 5. Died

8.3. Principal Investigator's Curriculum Vitae

Personal data:

Name: Dr. Tesfahun Kebede Nunne

Date of Birth: May 22, 1994

Place of birth: Hosanna, Hadiya zone, Central Ethiopia region.

Gender: Male

Current home Town: Harar, Ethiopia

Present Nationality: Ethiopian

Address: Telephone Mobile: +251-934131544/ +251-706951544

Email: bhope.tesf@gmail.com

Language:

Languages	Speaking	Listening	Writing	Reading
Amharic	Excellent	Excellent	Excellent	Excellent
English	Very good	Very good	Good	Very good
Hadiyissa	Good	Very good	Good	Good

Education:

- University: Degree of Doctor of Medicine, Addis Ababa University, Addis Ababa, Ethiopia, October 2012 - December 2018.
- Preparatory school: Vision Academy No. 1 Hosanna, Hosanna, SNNPR, Ethiopia, September 2010 – June 2012.
- Secondary school: Vision Academy No. 1 Hosanna, Hosanna, SNNPR, Ethiopia, September 2007 to June 2010.
- Elementary school: Vision Academy No. 1 Hosanna, Hosanna, SNNPR, Ethiopia, September 2000 to May 2007.

Work history:

- Medical Intern: Addis Ababa *University*. November 2017 to November 2018
- General Practitioner: Nigst Elleni Mohammed Memorial comprehensive Specialized University Hospital, Wachamo University, Hosanna. February 2019 to March 2021.
- Orthopeadics and trauma Surgery Resident: Haramaya University, April 2021 till present

Research Experience

- Working as a Co-investigator in a dual center prospective study currently conducting in HFCSUH, Haramaya University and Ayder comprehensive specialized university hospital, Mekelle University, Ethiopia.
- Took three sessions of training on clinical research organized by the joint Spanish Cooperation

Abridgment

- Possesses excellent interpersonal and physician-patient communication skills.
- Acquires the ability to develop and maintain trust and progress with patients.
- Enjoys being part of a successful and productive team and thrives in highly pressured and challenging working environments.
- Equipped with skills of working independently, planning timely, solving problems, and setting links/Memorandum of Understanding with Non-governmental Organizations.

8.4. Approval Sheet

HARAMAYA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

Pediatric orthopedics infections: prevalence, microbiological profile, management strategies, clinical outcomes and associated factors in Hiwot Fana comprehensive specialized university hospital, Harar, Ethiopia, 2025: A 3-year retrospective cross-sectional study.

Submitted by: -

Dr. Tesfahun Kebede Nunne	______________	________________
	Signature	Date

Approved by: -

1. ________________________	_______________	_________________
Major Advisor	Signature	Date
2. ________________________	_______________	_________________
Co-Advisor	Signature	Date
3. ________________________	_______________	_________________
Co- Advisor	Signature	Date
4. ________________________	_______________	_________________
Research Thematic Area Leader	Signature	Date
5. ________________________	_______________	_________________
Chairman, DGC/ SGC	Signature	Date
6. ________________________	_______________	_________________
Chairman, PGPD	Signature	Date