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Original Article

Epidemiology of Bone Tumors at Prof. Ngoerah General Hospital, Bali (2020-2023): A Referral Center Study in Eastern Indonesia

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Abstract

Introduction: Bone tumors, though rare, are a significant health concern due to their impact on quality of life and survival, particularly in paediatric populations. Studying bone tumors in Bali is critical, given the region's unique environmental, genetic, and healthcare challenges. Factors such as agricultural chemicals, volcanic ash exposure, genetic diversity, and delayed healthcare access may influence tumor prevalence and outcomes. IGNG Prof Ngoerah General Hospital, as the primary referral center for eastern Indonesia, provides a unique opportunity to examine the epidemiology of bone tumors in this region. This study aims to analyze the prevalence, patient demographics, tumor characteristics, and treatment patterns to inform improved diagnostic and therapeutic strategies.

Methods: This retrospective study analyzed 177 bone tumor cases diagnosed between 2020 and 2023. Data on patient demographics, tumor types, anatomical sites, and treatments were collected from medical records. Statistical analysis was conducted using IBM SPSS Statistics version 25.0. Descriptive statistics summarized continuous and categorical variables. Chi-square tests were used to assess associations between age groups, gender, and tumor characteristics, with a significance threshold of $p < 0.05$. Linear regression analysis evaluated temporal trends.

Results: The majority of cases (58%) occurred in patients aged 0-15 years, with a slight female predominance (56%). Osteosarcoma was the most common tumor, primarily affecting the femur. Significant associations were identified between age groups and tumor types. Healthcare access limitations contributed to delayed presentations, particularly in rural areas.

Conclusion: This study highlights the need for early detection programme and improved diagnostic access in rural areas. Multidisciplinary care and public health strategies are essential to enhance outcomes. Further research on local risk factors is recommended.

Keywords: Bone Tumor, Epidemiology, Outpatient, Bali

Introduction

Bone tumors are a heterogeneous group of neoplastic conditions affecting the skeletal system. They range from benign to malignant types and often have a profound impact on patients' lives. These tumors can necessitate specialized medical care and surgical interventions and may result in long-term disability or mortality. Although bone tumors are relatively rare compared to other cancers, they present a significant clinical challenge due to their complexity and the wide variety of subtypes that arise within bone tissue.[1]

This study focuses on the epidemiology and characteristics of bone tumors in Bali, Indonesia, with a specific emphasis on IGNG Prof Ngoerah General Hospital. Bali is not only a renowned cultural and tourism hub but also home to a diverse population. Unique genetic and environmental factors in the region may influence the prevalence and presentation of bone tumors. Additionally, IGNG Prof Ngoerah General Hospital serves as the primary referral center for bone tumor cases in eastern Indonesia, making it a key institution for studying this condition. Understanding the epidemiological patterns of bone tumors in this region is critical for improving clinical management and informing public health policies.[2]

Bone tumors are categorized into two main groups:

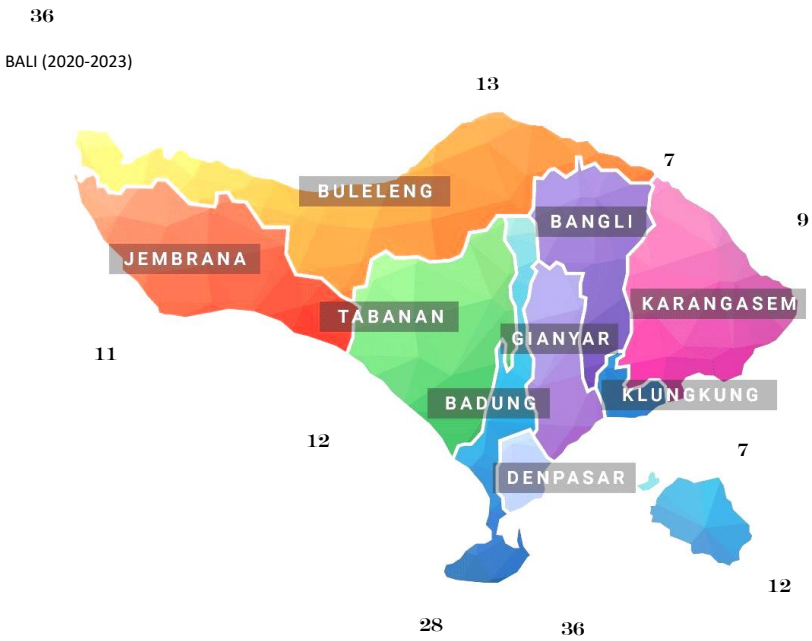

Figure 1. Distribution Map of Musculoskeletal Tumor Cases Referred to Prof Ngoerah General Hospital (01 January 2020 - September 2023).

primary tumors, which originate within bone tissue, and secondary (metastatic) tumors, which result from the spread of cancer from other sites.[3] While primary tumors can be benign or malignant, secondary tumors often indicate advanced malignancies and are associated with poor outcomes. Accurate diagnosis and classification are essential for determining effective treatment strategies, underscoring the need for comprehensive epidemiological data.[4]

Globally, some regions have established robust epidemiological data on bone tumors. However, such studies remain limited in Bali and the broader Indonesian context. The unique genetic makeup and environmental factors in Bali may result in distinct patterns of tumor types, age of onset, and disease burden. Advances in diagnostic and treatment modalities over the years also likely impact these patterns.

The objective of this study is to address this gap by providing a detailed retrospective analysis of bone tumor cases at IGNG Prof Ngoerah General Hospital from 2020 to 2023. By analyzing patient demographics, tumor characteristics, anatomical sites, and treatment outcomes, this research seeks to provide insights that will enhance clinical practices, facilitate early detection, and ultimately improve the quality of life for individuals affected by bone tumors in Bali.

Materials and Methods

Data Collection

We conducted a retrospective study of bone tumor cases diagnosed and treated at IGNG Prof Ngoerah General Hospital in Bali, Indonesia, covering the period from January 1, 2020, to September 2023. This four-year timeframe allows for an extensive analysis of trends and changes in the epidemiological landscape of bone tumors in the region.

Data were collected from the hospital's electronic medical records system, including patient admission records, radiology reports, pathology reports, and treatment records. These records contain detailed information about patient demographics, clinical pre sentations, diagnostic procedures, tumor characteristics, treatment modalities, and outcomes.

Data Variables

The wealth of data extracted from the medical records encompassed a spectrum of key variables essential for a comprehensive epidemiological analysis. Among these variables were patient demographics, encompassing age, gender, and referral location or source, providing an overarching view of the affected population. The study also meticulously classified bone tumors, distinguishing between benign and malignant variants while specifying subtypes where

applicable. The anatomical site of the bone tumor within the skeletal system was another crucial variable, shedding light on the distribution and localization of these tumors. Furthermore, the diagnostic methods employed, such as laboratory tests, were meticulously recorded.

Data Cleaning and Validation

Before commencing the analysis, a rigorous data cleaning process was undertaken to ensure the accuracy and consistency of the dataset. This involved identifying and addressing missing or incomplete data points through verification and appropriate imputation methods when necessary. Validation checks were meticulously executed to minimize the risk of errors stemming from data entry and extraction processes, ensuring the dataset's reliability and integrity.

Study Population and Eligibility Criteria

This study included patients diagnosed with bone tumors at IGNG Prof Ngoerah General Hospital between January 1, 2020, and September 30, 2023. The eligibility criteria were as follows:

Inclusion Criteria

1. Patients diagnosed with primary or secondary (metastatic) bone tumors within the study period.
2. Diagnoses confirmed through histopathological, radiological, or clinical findings.
3. Patients who received treatment or were managed at IGNG Prof Ngoerah General Hospital during the study period.
4. Availability of complete medical records, including demographic details, diagnostic data, and treatment history.

Exclusion Criteria

1. Patients with incomplete or missing medical records, particularly those lacking critical demographic or diagnostic information.
2. Cases with uncertain or unconfirmed diagnoses due to pending histopathological results.
3. Patients diagnosed with benign soft tissue tumors or malignancies unrelated to bone tissue.
4. Patients who were referred to other healthcare facilities before receiving definitive diagnosis or treatment at IGNG Prof Ngoerah General Hospital.

By applying these criteria, the study focused on cases with sufficient clinical and diagnostic data to ensure reliable analysis. This approach minimized biases related to incomplete information and allowed for a comprehensive evaluation of the epidemiological characteristics of bone tumors in the study population.

Data Analysis

The heart of this study involved a meticulous data analysis that unveiled the characteristics and trends in bone tumor cases in Bali. Descriptive statistics played a pivotal role in summarizing the dataset, offering insights into the frequency distributions, central tendencies (means and medians), and dispersions (standard deviations) for continuous variables. Categorical variables were expressed as percentages, providing a clear picture of the prevalence of various aspects within the dataset.

Temporal trends, a focal point of this analysis, allowed us to discern significant changes and patterns in the incidence and types of bone tumors across the study period. Furthermore, subgroup analyses were considered to explore potential variations in epidemiological patterns across age groups, genders, tumor types, and anatomical sites.

Through these rigorous methods, this study endeavours to provide a comprehensive and reliable portrayal of the epidemiological landscape of bone tumors in Bali, Indonesia, offering invaluable insights for both clinical practice and future research in this crucial field of study.

The data were analyzed using IBM SPSS Statistics version 25.0. Descriptive statistics were employed to summarize continuous variables, such as age and treatment duration, using measures of central tendency (mean, median) and dispersion (standard deviation). Categorical variables, such as gender distribution, tumor types, and anatomical sites, were expressed as frequencies and percentages. Chi-square tests were conducted to assess associations between demographic factors (e.g., age, gender) and tumor characteristics, with a significance level set at $P<0.05$. Linear regression analysis was applied to evaluate temporal trends in the incidence of bone tumors during the study period.

Results

An epidemiological study was conducted at IGNG Prof Ngoerah General Hospital in Bali from 2020 to

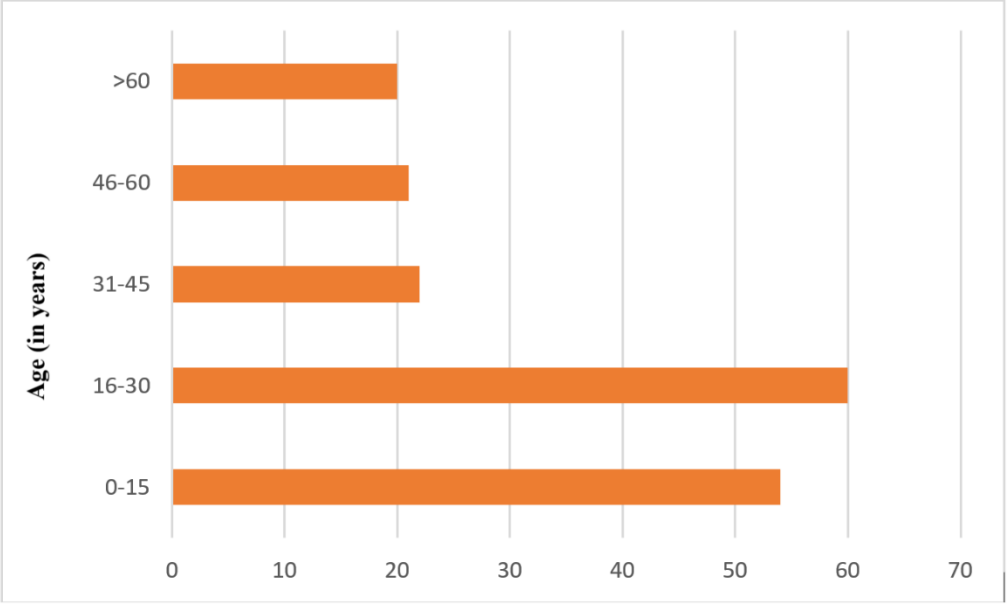

Figure 2. Age Distribution Graph of Patients.

2023 to analyze the distribution and characteristics of bone tumors. Data were collected from various locations in Bali and other regions of Indonesia.

The geographic distribution of cases showed that the majority of referrals were from various districts in Bali, as well as referrals from other regions in Indonesia, such as West Nusa Tenggara, East Nusa Tenggara, and East Java, highlighting urban areas as key contributors to the patient population.

The age distribution revealed that the highest number of cases occurred in the 0-15 years age group, followed by the 16-30 years age group. Gender distribution showed near parity between males and females, with a slight female predominance (56%).

The most common types of bone tumors identified were osteosarcoma, chondrosarcoma, and Ewing sarcoma. These were predominantly located in the femur, tibia, and radius, consistent with global trends. Osteosarcoma was the most frequently observed tumor, particularly affecting the metaphysis of long bones.

Statistical analyses, conducted using IBM SPSS Statistics version 25.0, included chi-square tests to identify associations between demographic factors and tumor types, with significant findings (P<0.05) observed for the association between age and tumor type.

This study provides valuable insights into the geographic and demographic distribution of bone tumors in Bali. The findings emphasize the need for region-specific strategies, including early detection and diagnostic programs, to improve outcomes for patients with bone tumors in the region.

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Discussion

The epidemiological analysis of bone tumors in Bali, Indonesia, presented in this research article, offers valuable insights into the prevalence, distribution, and characteristics of these neoplastic conditions in the region. The study, which spanned from 2020 to 2023, contributes to our understanding of bone tumor epidemiology and holds significance for clinical practice, healthcare management, and future research efforts.

Incidence and Types of Bone Tumors

The findings of this study align with global trends, demonstrating that bone tumors are relatively rare compared to other malignancies. Nevertheless, the detailed examination of cases in Bali has uncovered noteworthy variations in the types of bone tumors observed. Among these, osteosarcoma was the most common subtype. With an annual incidence of 5.6

cases per million children under the age of 15, osteosarcoma is the third most prevalent malignancy in adolescents, after lymphomas and brain tumors.[5] Osteosarcoma is the most prevalent primary malignant bone neoplasm, accounting for 35.1% to 47% of all bone malignancies.[6] These epidemiological insights provide a foundation for tailoring diagnostic and therapeutic strategies to the specific tumor types prevalent in the region.

Demographic Patterns

Patient demographics play a pivotal role in understanding the epidemiology of bone tumors. In this study, an examination of age and gender distributions has revealed intriguing patterns. People aged 0-15 years tend to be more prone to cancer, which may be indicative of underlying genetic, environmental, or lifestyle factors. Besides, this result is in accordance with the dominant subtype of tumor which is osteosarcoma. In young individuals, it typically appears close to the metaphysis of the long bones. Osteosarcoma (56%) is the most prevalent cancer in children and adolescents.[7] Further exploration of these demographic variations is warranted to identify potential risk factors and inform targeted prevention and early detection efforts.

Table 1. Age and Gender Distribution of Patients

Age	Female	Male	n
0-15	30	24	54
16-30	20	30	60
31-45	9	13	22
46-60	8	13	21
>60	6	14	20

Table 2. Overview of Patient Laboratory Results

Biomarker	N	Mean ± SD	Range	Median
CRP	177	27,42 ± 44,73	0,30-232,30	7,50
LDH	177	399,45 ± 302,40	21,00-2154,00	343,00
ALP	177	201,01 ± 275,11	0,30-245,00	133,00
LED	177	44,51 ± 36,71	1,90-14,00	35,00

The overview of patient laboratory results showed that the mean values of biomarkers such as CRP, LDH, ALP, and LED were within the normal range.

Anatomical Distribution

The study's analysis of the anatomical distribution of bone tumors is vital for accurate diagnosis and treatment planning. The data underscore that bone tumors in Bali exhibit a diverse distribution across skeletal sites, with the femur emerging as prominent locations. Osteosarcoma frequently occurs near the metaphysis of the long bones of the appendicular skeleton. The femur (42%), the tibia (19%), and the humerus (10%) are the most frequent sites.[7] The femur (9%) has the highest incidence of osteosarcoma. According to the "laws of field behaviour and developmental anatomy" of the damaged bone, a theory made popular by L.C. Johnson, this placement is explicable. In the metaphysis, the skeletal remodelling process and the related osteoblastic activity are dominant. As a result, this area is where most osteosarcomas tend to develop. Adolescents are primarily affected by this remodelling, which is interesting because this age group has the highest incidence of osteogenic sarcoma.[8] Understanding these patterns aids clinicians in precisely localizing tumors and tailoring therapeutic approaches to maximize efficacy and minimize morbidity.

Diagnostic and Treatment Landscape

The study highlights the pivotal role of diagnostic procedures and treatment modalities in managing bone tumors in Bali. Diagnostic methods, including advanced imaging techniques and histopathological examinations, were instrumental in confirming tumor types and guiding treatment decisions. Furthermore, the diverse array of treatment modalities, including surgery, chemotherapy, and radiation therapy, was selected based on tumor type and patient characteristics. These findings emphasize the importance of comprehensive diagnostic and therapeutic capabilities in the region.

Bali as a Referral Center for Eastern Indonesia

Bali's unique position as the primary referral center

Year	Within Bali	Outside of Bali
2020	- Badung : 6 - Bangli : 2 - Buleleng : 4 - Denpasar :13 - Gianyar : 6 - Jembrana :1 - Karangasem : 4 - Klungkung : 2 - Tabanan : 3	- Jawa timur : 1 - West Nusa Tenggara : 1 - East Nusa Tenggara : 2
2021	- Badung : 5 - Bangli : 1 - Buleleng : - - Singaraja : 6 - Denpasar : 5 - Gianyar : 1 - Jembrana : - - Karangasem : 2 - Klungkung :1 - Tabanan : 1 - Negara : 2	- West Nusa Tenggara : 9 - East Nusa Tenggara : 4
2022	- Badung : 9 - Bangli : 2 - Buleleng - Singaraja : 5 - Denpasar : 2 - Gianyar : 2 - Jembrana - Karangasem : 2 - Klungkung : 1 - Tabanan : 6 - Negara : 5	- West Java : 1 - East Java : 1 - West Nusa Tenggara : 10 - East Nusa Tenggara : 3 - Middle Sulawesi : 2
2023	- Badung : 8 - Bangli : 2 - Buleleng - Denpasar : 8 - Gianyar : 3 - Jembrana - Karangasem : 1 - Klungkung : 1 - Tabanan : 2 - Negara : 3 - Singaraja : 5	- West Nusa Tenggara : 8 - East Nusa Tenggara : 1 - Middle Sulawesi :1 - North Sulawesi :1

for bone tumor cases in the eastern part of Indonesia underscores its significance in the healthcare landscape. This central role ensures that patients from a vast geographical area have access to specialized care, expertise, and advanced diagnostic and treatment options. Moreover, the centralization of data and expertise at IGNG Prof Ngoerah General Hospital in Bali facilitates in-depth epidemiological studies like the one conducted, enhancing our understanding of bone tumor patterns and outcomes.

Implications for Healthcare Management

The epidemiological insights gained from this study have direct implications for healthcare management in Bali and the eastern part of Indonesia. Healthcare providers in the region must tailor their approaches to the unique epidemiological characteristics of bone tumors, including early detection strategies, optimized treatment plans, and targeted patient education efforts. Additionally, resource allocation must continue to meet the demands of patients referred for bone tumor management, including maintaining expertise, diagnostic capabilities, and treatment options. Furthermore, the centralization of data and expertise in Bali opens doors for collaborative research efforts, both nationally and internationally, which can drive advances in bone tumor diagnosis and treatment.

Diagnostic Challenges

This study identified several challenges in diagnosing bone tumors in Bali. Limited access to advanced imaging modalities, such as MRI and PET scans, in rural areas often delays accurate diagnosis. Histo pathological services, critical for confirming tumor types, are centralized at referral centers like IGNG Prof Ngoerah General Hospital, resulting in delayed referrals

Table 4. Distribution of Tumor Locations and Types

Tumor Location	Giant Cell tumor	Higroma	Liposarcoma	Aneurysmal Bone Cyst	Chondroma	Leiomyosarcoma	Myxoid Sarcoma	Round Cell Tumor	Spindel cell sarcoma
Calcaneus									
Clavicle									
Scapula			2						
Cruris									
Femur		2	1	1					
Hip			1						
Humerus									
Knee			1						1
Fibula									
Tibia									
Ankle									
Arm									
Thigh			1				1	1	
Forearm									
Leg			2			2	1		
Shoulder									
Illiac								1	
Manus									
Radius	1								
Sacral					1				
Pelvic									

Tumor Location	SBC	MM	SCC	Ewing Sarcoma	ABC	GCT	Adamantinoma	Chondrosarcoma	Condrolastoma	Enchondroma	Fibrosarcoma	Hemangioma	MBC	Neurofibroma	Osteochondroma	Osteosarcoma	Rhabbdomysarcoma
Calcaneus	1																
Clavicle		1						1					1			2	
Scapula																1	
Cruris			1					1									
Femur	2	1	2	1	1	1		3	1	1		4			2	35	
Hip								2								1	2
Humerus		1		1				1								15	
Knee				1		2		1								5	1
Fibula			1	1		1										2	
Tibia			2	2											1	17	
Ankle			1												1		
Arm																2	
Thigh											1					3	2
Forearm												1					2
Leg							1	2						1		2	
Shoulder											1						
Illiac				1				6									
Manus										1							
Radius																3	
Sacral																	
Pelvic								1									

and prolonged waiting times for pathology results. These barriers disproportionately affect patients from remote regions, highlighting the need to expand diagnostic facilities and train healthcare professionals in early detection and referral systems.

Areas for Future Research

Future studies should focus on the potential environmental and genetic factors influencing bone tumor incidence in Bali. For instance, the role of environmental exposures, such as agricultural chemicals and volcanic ash, in tumor development warrants investigation. Additionally, studies on genetic susceptibility specific to the Balinese population could provide insights into prevention and personalized treatment strategies. Research on cost-effective diagnostic methods suitable for resource-limited settings would also enhance early detection capabilities.

Table 5. Total Distribution of Each Tumor Location

Tumor Location	(n)
Calcaneus	1
Clavicle	5
Scapula	3
Cruris	2
Femur	58
Hip	6
Humerus	18
Knee	12
Fibula	5
Tibia	22
Ankle	2
Arm	2
Thigh	9
Forearm	3
Leg	11
Shoulder	1
Illiac	8
Manus	1
Radius	4
Sacral	1
Pelvic	1
Total	177

Study Limitations

This study has several limitations. As a retrospective analysis, it relied on the accuracy and completeness of medical records, which may introduce bias. Furthermore, the study was conducted at a single referral center, which may not fully represent the broader population. The lack of detailed data on socioeconomic factors and long-term treatment outcomes also limits the scope of conclusions. Future multicenter studies incorporating prospective designs are recommended to address these gaps.

Conclusion

This epidemiological study of bone tumors in Bali, focusing on IGNG Prof Ngoerah General Hospital, provides valuable insights into the regional prevalence, demographics, and clinical characteristics of these conditions. Bali's role as the primary referral center for bone tumors in eastern Indonesia underscores its critical position within the healthcare landscape. This centralization not only highlights the demand for specialized care but also points to the challenges faced by patients from remote areas, including delayed referrals and limited access to advanced diagnostic facilities.

The findings of this study emphasize the importance of resource allocation to strengthen Bali's diagnostic and therapeutic capacities. Expanding access to advanced imaging and histopathological services, coupled with training healthcare providers in early detection and referral systems, can significantly improve patient outcomes. Moreover, this study establishes a foundation for collaborative research efforts and serves as a catalyst for refining healthcare strategies tailored to the unique epidemiological patterns of bone tumors in the region.

Future research should explore the genetic and environmental risk factors specific to Bali's population, as well as long-term treatment outcomes. These efforts will enhance understanding, inform prevention strategies, and support the development of cost-effective diagnostic and treatment protocols. Ultimately, this work aims to improve the overall quality of care and prognosis for individuals affected by bone tumors in Bali and beyond.

Conflict of Interest

The authors declare no conflicts of interest.

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