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**Original Research Article**

# A Retrospective Review of Individuals Referred for Imaging with Suspected Lung Malignancy in Tanzania: Aspects of the Multi-National Lung Cancer Control Program

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**Abstract:** ***Background***: Lung cancer is the leading cause of cancer-related mortality worldwide and the tenth leading cause of death in Tanzania. Minimally invasive lung biopsy procedures using CT or bronchoscopy are now available in Tanzania. There is paucity of data on imaging outcomes of individuals referred for imaging with suspected lung malignancy. The aim of this study was to retrospectively review individuals referred for imaging with suspected lung malignancy from 1 January 2019 to 31 December 2024. ***Materials and Methods*:** This was a retrospective cross-sectional study on adult individuals that were referred for imaging with suspected lung malignancy. Data was retrieved from the Multi-national Lung Cancer Control Program in the Lake Zone research database. Frequencies or proportions were used for categorical variables. Pearson's chi square test and logistic regression analysis was used to determine association factors of malignancy. ***Results*:** Around 512 individuals were enrolled with median age (IQR) of 56 (43 – 67) years. About 55.6% (273 out 495) presented with a mass on imaging. Of which, 87.2% (238 out 273) underwent biopsy based on visualization of a mass on imaging. Majority of the biopsied masses were malignant (62.6%) while the rest were benign (28.2%) and indeterminate (9.2%) lesions. On regression analysis, a mass on imaging had the highest likelihood on being malignant (aOR (95% CI) =14.0 (8.5 – 23.1). Conversely, features of tuberculosis on imaging had the least likelihood on being malignant (aOR (95% CI) = 0.59 (0.01 – 0.27). ***Conclusion*:** Visualization of a mass on imaging was highly predictive of malignancy, especially in the absence of features of tuberculosis. Indeterminate lesions posed diagnostic challenges due to lack of advanced imaging and molecular testing in our settings.

**Keywords:** Lung Cancer, Imaging, CXR, CT, Biopsy, Outcomes.



## INTRODUCTION

Lung cancer is the top leading malignancy and the tenth leading cause of death worldwide and in Tanzania respectively [1, 2]. Cigarette smoking is the most prevalent lung cancer risk factor, although environmental exposures, such as biomass fuels, asbestos, arsenic and radon, are all important lung factor risk factors with levels of exposure that vary widely across the globe [3]. Various imaging modalities are available for the detection of lung cancer but the chest radiograph (CXR) is the first line and readily available imaging modality in low- and middle-income countries (LMICs). A systematic review and meta-analysis has shown that the CXR has a sensitivity of 81% and specificity of 68% for the detection of lung malignancy in a symptomatic primary-care population with a negative CXR not able to exclude lung malignancy [4]. Computed tomography (CT) is a modality used for lung cancer screening, diagnosis and staging due to its high resolution and with improved sensitivity of 98.8% and specificity of 99.6% when artificial intelligence (AI) is employed [5]. It is worth noting that in LMICs where resources are limited, challenges in accessing medical

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imaging by deserving populations may be the norm [6]. Therefore, CT services may not be always available or accessible in many primary care healthcare facilities. Lung biopsy is crucial in the retrieval of histological specimens that confirm presence and type of lung malignancy, and thus determining management [7]. Minimally invasive lung biopsy procedures using CT or bronchoscopy are now available in Tanzania. There is paucity of data on imaging outcomes of individuals referred for imaging with suspected lung malignancy. Therefore, this study aimed to retrospectively review individuals referred for imaging with suspected lung malignancy in Tanzania.

## MATERIALS AND METHODS

### Study Design, Duration and Setting

This was a hospital based retrospective cross-sectional study that was carried out between August and October 2025 at Bugando Medical Centre in Mwanza Tanzania.

### Study Population

All adult individuals that were referred for imaging with suspected lung malignancy.

### Eligibility Criteria

All adult (18 years and older) individuals, that were referred for imaging with suspected lung malignancy from 1 January 2019 to 31 December 2024 included. Individuals with missing data were excluded.

### Study Variables

Exposure variables included age, sex, features of tuberculosis (Tb) or mass on imaging. Outcome variable was presence of lung malignancy.

### Sample Size

All adult individuals that were referred for imaging with suspected lung malignancy.

### Data Collection and Procedures

Data was retrieved from the Multi-national Lung Cancer Control Program in the Lake Zone research database. Data was anonymized and entered into Microsoft Excel (Microsoft Corporation, USA). CXR was acquired on GE XR-6000 X-ray machine (GE Hualun Medical Systems Co. Ltd, China). Contrasted CT that included the chest and upper abdomen was acquired by a 128 slice CT scanner (Siemens Healthineers, Germany) or 64 slice CT scanner (GE Healthcare Corporation, Japan). All images were reported by an experienced radiologist. Any mass on imaging underwent biopsy. Biopsy was either done under CT imaging guidance using a transthoracic 18 gauge coaxial needle at the radiology department or by bronchoscopy at the cardiothoracic surgery department depending on the location of mass. All biopsies were done by specialists to ensure optimal sampling and avoid potential procedural complications such as bleeding or pneumothorax. Biopsy specimens were immediately stored in a labeled 10% formalin container and sent to histopathology for processing, interpretation and reporting by an experienced pathologist.

### Data management and Statistical Analysis

Data was exported to Stata version 17 (StataCorp LLC, USA) for cleaning and analysis. Any missing data was excluded from analysis. Data was presented as mean with standard deviation (SD) or median with interquartile range (IQR) for continuous variables. Frequencies or proportions were used for categorical variables. Pearson's chi square test ($\chi^2$) or Fisher's exact test was applied to determine associations between exposure and outcome variables. Univariate and multivariate logistic regression analysis was further applied to determine the odds of malignancy. A p-value of <0.05 was considered statistically significant.

### Ethical Consideration

The study clearance was requested and approved by the CUHAS/BMC Research and Ethical Committee (No. CREC/868/2024).

## RESULTS

Out of the 525 individuals assessed for eligibility, only 512 individuals were enrolled (Figure 1).

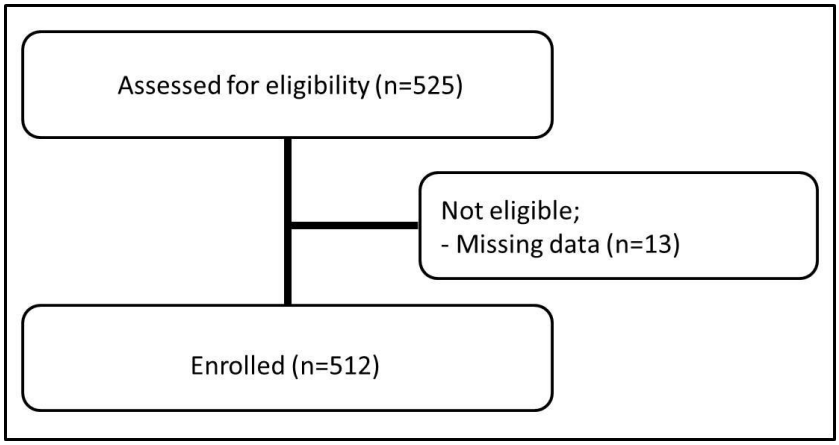


**Figure 1: Recruitment flow chart**

Individuals had an age range of 18 to 98 years old and age median (IQR) of 56 (43 - 67) years. Majority of the individuals were males (54.9%) and older than 40 years old (77.9%). Around 55.6% (273 out 495) presented with a mass on imaging. Around 87.2% (238 out 273) underwent biopsy based on visualization of a mass on imaging (Table 1).

**Table 1: Baseline Characteristics (n=512)**

| Variable | Category | n (%) |
|---|---|---|
| Age, years | 18 – 40 | 113 (22.1) |
| | ≥41 | 399 (77.9) |
| Sex | Female | 231 (45.1) |
| | Male | 281 (54.9) |
| CXR (n=505) | No | 73 (14.5) |
| | Yes | 432 (85.5) |
| CT Chest (n=506) | No | 106 (20.9) |
| | Yes | 400 (79.1) |
| Tb on imaging (n=486) | No | 436 (89.7) |
| | Yes | 50 (10.3) |
| Mass on imaging (n=495) | No | 222 (44.9) |
| | Yes | 273 (55.6) |
| Both Tb and mass on imaging (n=474) | No | 465 (98.1) |
| | Yes | 9 (1.9) |
| Biopsy (n=273) | No | 35 (22.9) |
| | Yes | 238 (87.1) |

Tb, tuberculosis; CXR, chest X-ray; CT, computed tomography.

Of the individuals who underwent biopsy, majority of the biopsied masses were malignant (62.6%) when compared to benign (28.2%) and indeterminate (9.2%) lesions. The most common malignant histology was non-small cell lung carcinoma (NSCLC) at 50.4% followed by small cell lung carcinoma (SCLC) at 4.2% (Figure 2). Majority (56%) of individuals presented at advanced stages (Figure 3). Tb or mass on imaging was significantly associated with malignancy ($p<0.001$) (Table 2).

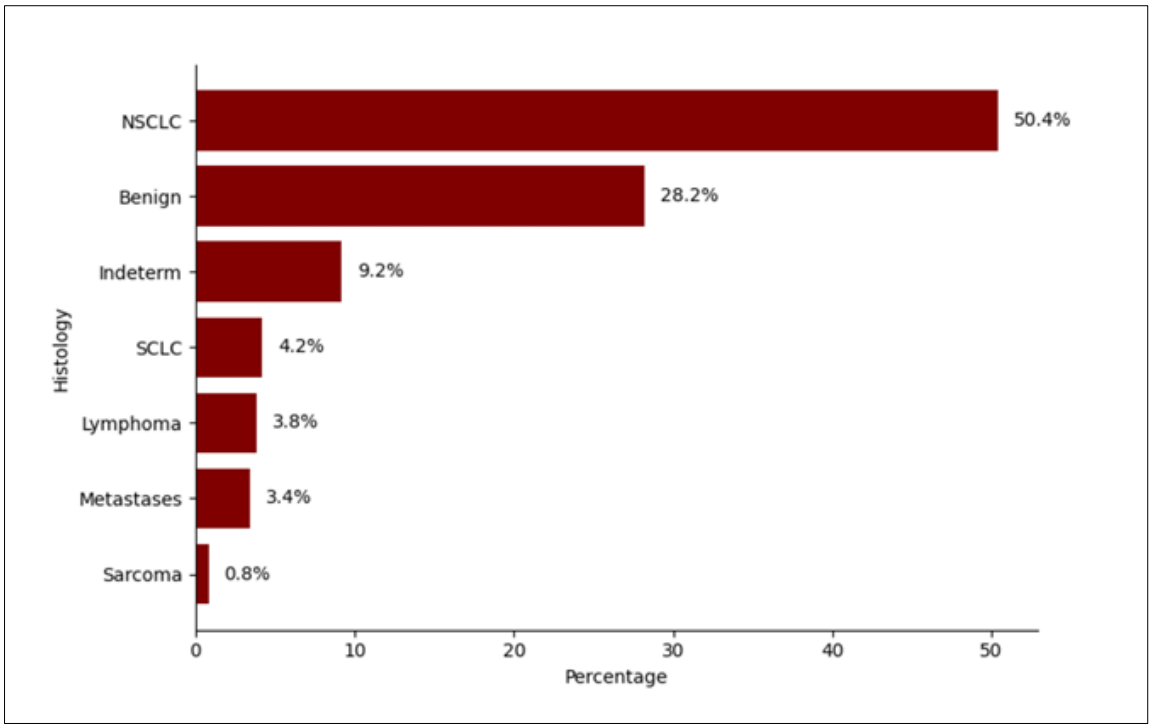


**Figure 2: Bar graph showing histological categories after biopsy (n=238)**

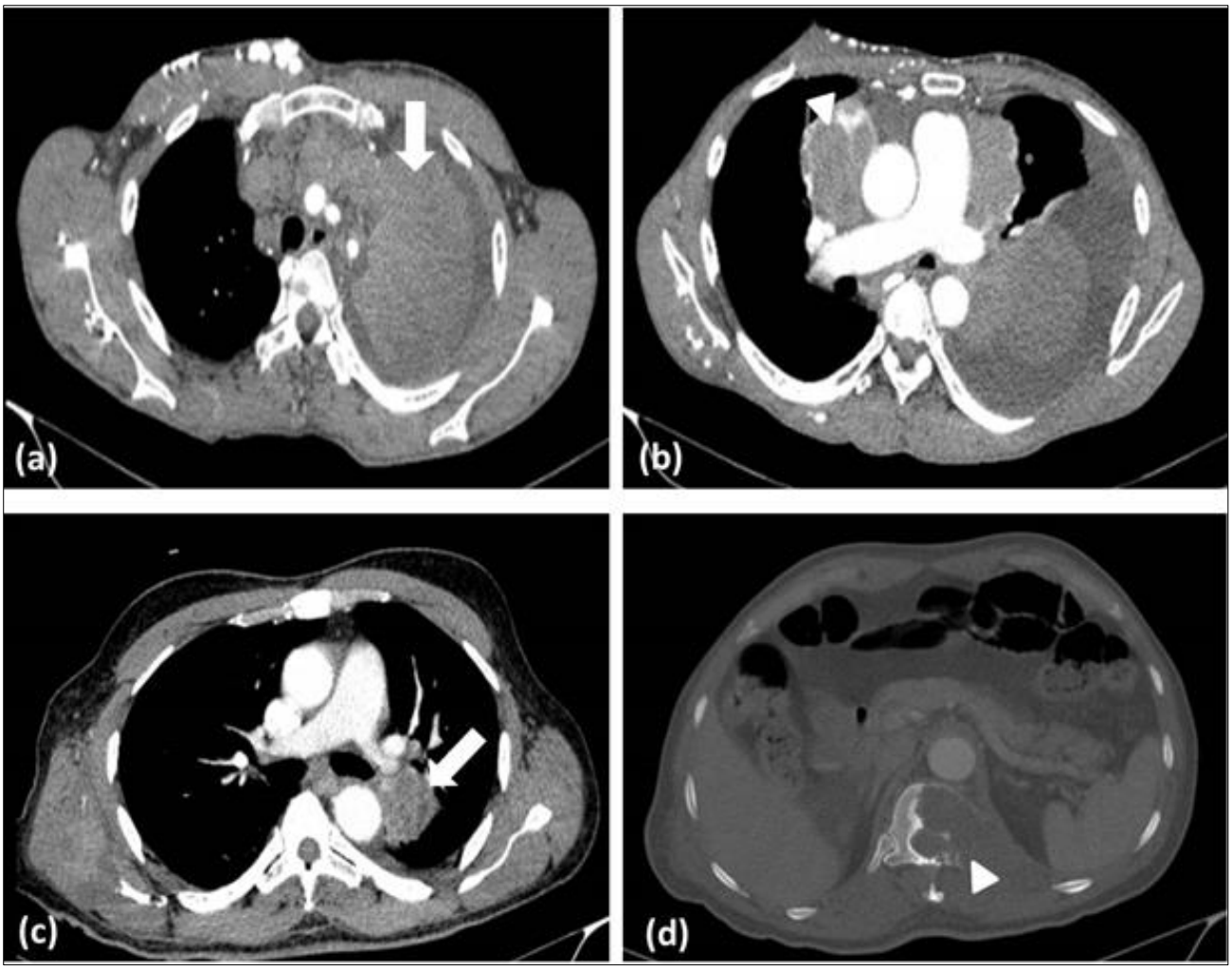


**Figure 3: Contrasted CT axial images illustrating advanced stages of NSCLC. Images (a) and (b) showing left upper lobe mass (white arrow) with tumor encroaching into and completely attenuating the lumen of the superior vena cava (white arrowhead) causing superior vena cava syndrome in a 57 years old male. Images (c) and (d) showing a left hilar mass (white arrow) and a destructive lytic bony lesion involving the left aspect of T12 vertebral body and the left costovertebral junction (white arrowhead) in a 66 years old male**

**Table 2: Factors associated with malignancy**

| Variable | Category | Malignant | | $\chi^2$ | p |
|---|---|---|---|---|---|
| | | No, n (%) | Yes, n (%) | | |
| Age, years (n=486) | 18 – 40 | 62 (58.5) | 44 (41.5) | 1.83 | 0.18 |
| | ≥41 | 194 (51.0) | 186 (49.0) | | |
| Sex (n=486) | Female | 111 (50.2) | 110 (49.8) | 0.97 | 0.32 |
| | Male | 145 (54.7) | 120 (45.3) | | |
| Tb on imaging (n=482) | No | 207 (47.6) | 228 (52.4) | * | <0.001 |
| | Yes | 45 (95.7) | 2 (4.3) | | |
| Mass on imaging (n=472) | No | 172 (84.3) | 32 (15.7) | 149.2 | <0.001 |
| | Yes | 74 (27.6) | 194 (72.4) | | |

Tb, tuberculosis. * Fisher's exact test

On further analysis using univariate and multivariate logistic regression, a mass on imaging had the highest likelihood on being malignant (aOR (95% CI) = 14.0 (8.5 – 23.1), p<0.001). Conversely, distinctive features of Tb on imaging had the least likelihood on being malignant (aOR (95% CI) = 0.59 (0.01 – 0.27), p<0.001) (Figure 4).

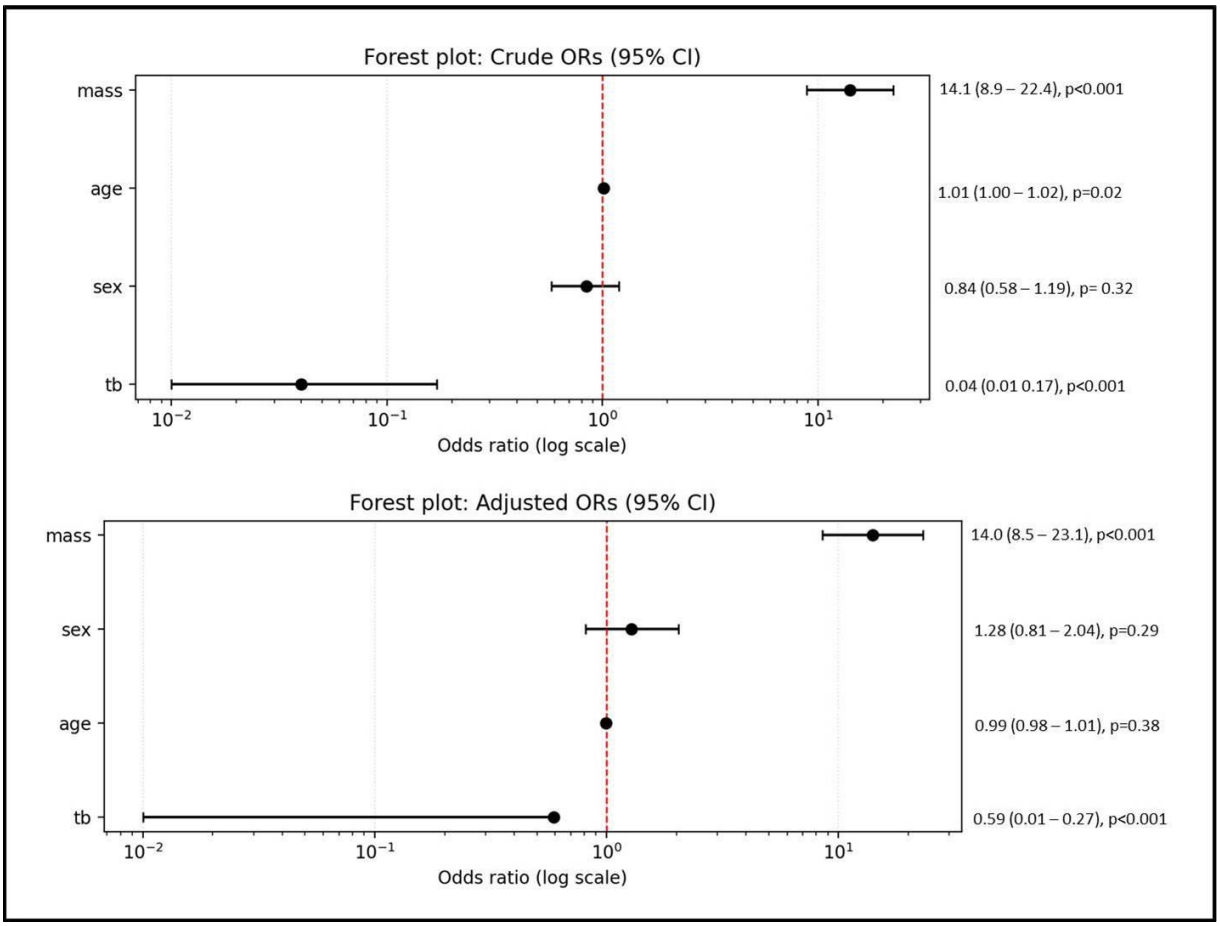


**Figure 4: Forest plots showing odds of malignancy according to age, sex, Tb or mass on imaging**

## DISCUSSION

Majority of the individuals who underwent biopsy had malignant lesions (63%) while minority of the suspected masses turned to be benign (28%) or indeterminate (9%). This demonstrated an above average index of suspicion of malignancy detection on imaging. Half of the malignant lesions on histology were NSCLC, which was the commonest lung malignancy, followed by SCLC almost analogous to other reported studies [8, 9].

In our study, a mass on imaging was fourteen-fold most likely to be malignant whereas, individuals who had distinctive features of Tb on imaging were least likely to have malignancy. In published studies that compared the differences in imaging features between individuals with Tb alone and individuals with Tb complicated with lung cancer, CT had an effective value in distinguishing Tb alone from Tb complicated with lung cancer [10,11].

Some lesions seen on CT in our study, such as lymphoma and metastases which constituted 7% of the study population, masqueraded as lung cancer on imaging but were only detected on histology. Lymphoma is renowned for encasing rather than invading anatomical structures. Rarely, lymphoma has been reported to invade the pulmonary vein and left atrium with tumor thrombus formation suggestive of advanced lung cancer [12]. For indeterminate lesions, it was rather difficult to get to the final diagnosis due to resource limitations at our hospital, as such lesions required advanced whole body imaging such as positron emission tomography/computed tomography (PET/CT) and diffusion weighted imaging (DWI) which were lacking. PET/CT and DWI which have been primarily used as diagnostic tools for lung cancer with a move towards utility of artificial intelligence [13]. Molecular testing can also be used by pathologists to resolve indeterminate lesions using various recommended biomarkers [14].

Our study gives an insight into imaging outcomes of individuals referred with suspected lung malignancy where a significant proportion of individuals presented at advanced stage of disease. In our setting, most individuals who present with chest symptoms were sometimes misdiagnosed as Tb in peripheral hospitals and placed on Tb drug regimens for months without any significant response. Non-response to Tb treatment, in most favourable circumstances, the attending clinician may refer the patient to other hospitals in search for alternate diagnoses such lung cancer. However, least favourable circumstances drive individuals to seek alternative treatment elsewhere which may not be limited to traditional or spiritual healers [15]. All in the end, compounded by poor access or unavailability of

diagnostic imaging services [6], may contribute to delay in diagnosis of lung cancer and late presentation of disease.

# CONCLUSION

Visualization of a mass on imaging was highly predictive of malignancy, especially in the absence of features of tuberculosis. Indeterminate lesions posed diagnostic challenges due to lack of advanced imaging and molecular testing in our settings.

**Contributors**

The study was conceived and designed by PSN and NAM. All authors contributed to the data collection, analysis and/or interpretation of the findings. PSN drafted the first version of the manuscript. All authors reviewed and revised the manuscript for intellectual content and approved the final version for submission.

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**Competing Interests:** All authors declare no conflict of interests.

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**Data Availability**

The de-identified participant data, data sets generated and analyzed are available from the corresponding author upon a reasonable and ethical request.

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