RESEARCH PAPER

# Radiologic Patterns Of Lung Cancer In Non-Smoking Urban Females: A Structured Descriptive Framework

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**Abstract**

**Background:** Lung cancer among never-smokers is increasingly acknowledged, especially among metropolitan women, and exhibits unique clinicoradiologic features. These patterns are frequently nuanced and may coincide with benign or infectious illnesses.

**Objective:** To establish a systematic descriptive framework for analyzing radiologic trends of lung cancer in non-smoking metropolitan women.

**Methods:** A literature-informed methodological framework was developed. Radiologic features were identified through targeted searches of pubmed, scopus, and google scholar, grouped into domains, and organized into a simplified interpretative model.

**Results:** Distinctive patterns encompass peripheral lesion distribution, ground-glass opacities, and subsolid nodules, sometimes linked to adenocarcinoma. A sequential interpretative framework and diagnostic flow model were developed.

**Conclusion:** A structured descriptive approach may assist clinicians and radiologists in recognizing radiologic patterns suggestive of lung cancer in non-smoking urban females, particularly in settings with overlapping infectious diseases.

**Keywords:** Lung Cancer, Never-Smokers, Ground-Glass Opacity, Radiologic Patterns, Adenocarcinoma.

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## INTRODUCTION

Lung cancer in never-smokers is a significant percentage of worldwide lung cancer cases and is particularly prevalent among women and urban demographics [1,2]. This subgroup is identified as a unique clinical entity, exhibiting variations in epidemiology, molecular profile, and imaging characteristics relative to smoking-related lung cancer [3].

Computed tomography (CT) is crucial in identifying and characterizing pulmonary lesions. Lung cancer in never-smokers frequently manifests as ground-glass opacities (GGOs) or subsolid nodules, potentially indicating early or preinvasive disease [4]. The imaging results are frequently mild and may coincide with benign or inflammatory conditions, resulting in diagnostic ambiguity. In places endemic to tuberculosis, such as India, these radiologic characteristics may be erroneously interpreted as infectious disease, resulting in delays in diagnosis and treatment. Notwithstanding these obstacles, there is minimal focus on the systematic analysis of such patterns in standard practice.

This study presents a straightforward descriptive framework to categorize and analyze radiologic characteristics linked to lung cancer in non-smoking metropolitan women.

## Methods

### Study Design

This study was designed as a descriptive methodological framework development aimed at organizing radiologic features associated with lung

cancer in non-smoking urban females into a structured interpretative model. The objective was to synthesize existing evidence and translate it into a clinically applicable radiological framework. The study did not involve human participants, patient data, or primary imaging datasets, and was purely based on secondary literature analysis.

**Literature Identification Strategy**

To inform the development of the framework, a targeted literature search was conducted across major biomedical databases, including PubMed/MEDLINE, Scopus, and Google Scholar. The search was restricted to articles published in the English language. Relevant keywords such as "lung cancer," "never smokers" or "non-smokers," "female," "ground-glass opacity," "subsolid nodules," "CT imaging lung cancer," and "adenocarcinoma imaging" were used. These keywords were combined using Boolean operators (AND/OR) to refine and optimize the search results. Additionally, the reference lists of selected articles were manually screened to identify further relevant studies that might not have been captured in the initial search.

**Selection Criteria**

Articles were considered eligible if they described radiologic features of lung cancer on computed tomography (CT), particularly in populations of never-smokers or predominantly non-smoking cohorts. Studies reporting imaging characteristics of adenocarcinoma and subsolid nodules were included, encompassing original research articles, review articles, and consensus guidelines. Studies focusing exclusively on smoking-related lung cancer were excluded, as were case reports lacking generalizable radiologic patterns and publications in languages other than English.

**Feature Extraction and Synthesis**

Radiologic features relevant to lung cancer in never-smokers were systematically identified and extracted from the selected literature. These included lesion morphology, such as ground-glass, part-solid, or solid nodules; lesion location, categorized as peripheral or central; margin characteristics, including smooth, irregular, or spiculated borders; and associated findings such as lymphadenopathy or pleural involvement. The extracted features were qualitatively synthesized to identify commonly recurring imaging patterns and to establish meaningful correlations between radiologic characteristics and malignancy risk in non-smoking populations.

**Framework Development**

The identified features were systematically organized into four primary domains: lesion type, anatomical location, morphological characteristics, and associated radiologic findings. These domains formed the basis of a structured interpretative framework. A risk-based model was subsequently developed by aligning specific combinations of these features with varying levels of suspicion for malignancy, thereby facilitating a more standardized and clinically relevant approach to radiologic interpretation.

**Development of Diagnostic Flow Model**

To enhance clinical applicability, a stepwise diagnostic flow model was developed based on the constructed framework. This model incorporates sequential evaluation of lesion characteristics, pattern recognition principles, and simplified decision-making pathways. The aim was to provide a practical tool that can assist radiologists and clinicians in systematically assessing CT findings and stratifying malignancy risk in non-smoking female patients

**Ethical Considerations**

This study did not involve human participants, patient data, or identifiable information. As it was based solely on previously published literature and did not include primary data collection, institutional ethics committee approval was not required.

**Results**

Radiologic features relevant to lung cancer in non-smoking urban females were organized into four principal domains: lesion type, anatomical location, morphological characteristics, and associated findings (Table 1 ).

**Table 1 : Principal Radiologic Features**

| Domain | Features |
|---|---|
| Lesion type | Ground-glass, part-solid, solid |
| Location | Peripheral, central |
| Margins | Smooth, irregular, spiculated |

| | |
|---|---|
| Associated findings | Lymphadenopathy, pleural effusion |

This classification reflects standard CT-based evaluation as described by Hansell *et al.* [5], who emphasized the importance of structured terminology in thoracic imaging. Lesion type and location serve as primary discriminators, while margin characteristics refine suspicion. Associated findings provide supportive evidence but are less specific.

A consistent clinicoradiologic pattern was identified in non-smoking urban females.

Table 2 : Clinicoradiologic Patterns

| **Parameter** | **Typical Finding** |
|---|---|
| Histology | Adenocarcinoma |
| Distribution | Peripheral |
| Morphology | Ground-glass / subsolid |

This pattern is supported by Travis *et al.* [3], who identified adenocarcinoma as the predominant subtype in never-smokers, typically arising in peripheral lung regions. Kobayashi *et al.* [4] further demonstrated that such tumors frequently present as ground-glass or part-solid nodules, reinforcing the observed pattern.

Ground-glass opacity represents a key radiologic feature with a spectrum of clinical implications (Table 3).

**Table 3 : Clinical Implications of Ground glass opacity**

| **GGO Type** | **Clinical Implication** |
|---|---|
| Pure GGO | Often preinvasive / early lesion |
| Part-solid nodule | Higher likelihood of invasive malignancy |

Goo [6] described ground-glass nodules as imaging biomarkers of early adenocarcinoma, while Kobayashi *et al.* [4] highlighted the progression from pure GGO to invasive disease. This supports the distinction between pure and part-solid lesions as a critical diagnostic indicator.

Radiologic patterns demonstrate correlation with molecular characteristics.

**Table 4 : Radiologic Features and its Associated Patterns**

| **Radiologic Feature** | **Associated Pattern** |
|---|---|
| Subsolid nodules | EGFR mutation association |
| Peripheral lesions | Adenocarcinoma phenotype |

Wei *et al.* [7] demonstrated a strong association between EGFR mutations and subsolid nodules, supporting a biological basis for these imaging patterns. This suggests that radiologic findings may reflect underlying tumor genomics.

A risk-based interpretation framework was developed.

**Table 5 : Risk Based Interpretation**

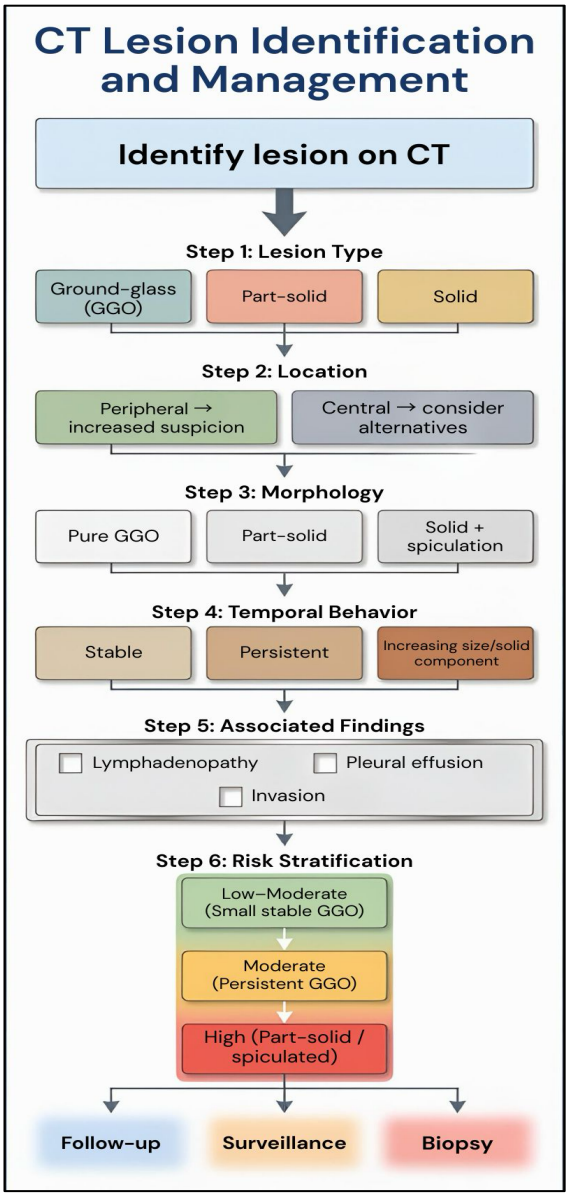
| **Radiologic Pattern** | **Suspicion Level** |
|---|---|
| Small stable GGO | Low–Moderate |
| Persistent GGO | Moderate |
| Part-solid nodule | High |
| Spiculated peripheral lesion | High |

This classification aligns with established observations by Goo [6] and Kobayashi *et al.* [4], where increasing solid components and spiculation correlate with invasive potential. The framework translates imaging findings into clinically actionable categories.

A stepwise diagnostic model integrates these domains into a practical workflow (figure 1) .

The sequential evaluation approach is consistent with radiologic reasoning principles and supports improved pattern recognition. In high tuberculosis-burden settings, such structured interpretation may reduce diagnostic ambiguity, as highlighted in studies on diagnostic overlap in never-smoker lung cancer [8].

**Figure 1 : Stepwise Radiologic Interpretation of Lung Lesions in Non-Smoking Urban Females**




**Discussion**

The present framework consolidates radiologic features of lung cancer in non-smoking urban females into a structured interpretative model, with findings closely aligned with established literature.

The domain-based classification reflects standardized thoracic imaging terminology as described by Hansell *et al.* [5], ensuring consistency in feature identification. The predominance of peripheral subsolid nodules corresponds with the observations of Travis *et al.* [3] and Kobayashi *et al.* [4], who identified adenocarcinoma as the dominant histology in never-smokers.

Ground-glass opacity plays a central role in early detection. Goo [6] demonstrated that GGOs function as imaging biomarkers of early adenocarcinoma, while Kobayashi *et al.* [4] highlighted their progression to invasive disease. These findings directly support the framework's emphasis on GGO spectrum and risk stratification.

The association between radiologic features and molecular characteristics further strengthens the framework. Wei *et al.* [7] reported that EGFR-mutated tumors frequently present as subsolid nodules, indicating that imaging patterns reflect underlying tumor biology.

Globally, lung cancer remains a leading cause of cancer mortality, with increasing recognition among never-smokers [1]. Environmental exposures such as air pollution are implicated in this trend [2]. In tuberculosis-endemic regions, overlap between infectious and malignant imaging patterns contributes to diagnostic delay [8].

The proposed framework integrates these findings into a simplified model that may enhance recognition and support clinical decision-making. While descriptive in nature, it provides a practical reference for routine radiologic interpretation.

**Recommendations**

Structured reporting should be adopted in routine CT interpretation by systematically incorporating lesion type, anatomical location, and morphological characteristics to enhance consistency and diagnostic clarity. Greater awareness of subsolid nodules is essential, as ground-glass opacities and part-solid lesions in non-smokers should not be prematurely considered benign without appropriate follow-up. Particular attention should be given to peripheral lesions, as their distribution may raise suspicion for adenocarcinoma in never-smokers. Follow-up protocols should be emphasized, especially for persistent or evolving ground-glass opacities, which may require interval imaging or further diagnostic

evaluation. In addition, regional context must be considered, particularly in tuberculosis-endemic areas, where careful differentiation between infectious and neoplastic patterns is crucial to avoid misdiagnosis.

**Future Directions**

Further research is required to validate the proposed framework through prospective or retrospective clinical studies assessing its diagnostic accuracy and clinical utility. Integration with radiogenomics represents a promising avenue, with future studies exploring correlations between imaging patterns and molecular markers such as epidermal growth factor receptor (EGFR) mutations. The framework may also serve as a foundation for the development of artificial intelligence–assisted diagnostic tools in thoracic imaging, potentially enhancing diagnostic precision and workflow efficiency. Additionally, population-specific studies focusing on urban female non-smokers in India are needed to refine screening strategies and improve the applicability of this model in regionally relevant clinical settings.

**Clinical Implications**

The proposed framework provides a simple and reproducible approach to radiologic interpretation, facilitating structured assessment of lung lesions in non-smoking females. It has the potential to improve early detection of adenocarcinoma in never-smokers by highlighting key imaging features associated with malignancy. Furthermore, it may help reduce diagnostic errors in infection-prone settings by promoting careful differentiation between benign and malignant patterns. Overall, the framework supports standardization of reporting practices and contributes to more consistent and clinically meaningful radiologic evaluations.

## Conclusion

Lung cancer in non-smoking urban females constitutes a distinct clinicoradiologic entity, predominantly exhibiting peripheral distribution and ground-glass or subsolid nodular patterns, most frequently associated with adenocarcinoma. These imaging characteristics are often subtle and can overlap with benign or infectious conditions, especially in regions where tuberculosis is endemic, which may result in delayed diagnosis. The structured descriptive framework introduced in this study incorporates key radiologic parameters, including lesion type, location, morphology, and associated findings, into a simplified, stepwise interpretative model. This model is designed to improve pattern recognition, minimize diagnostic variability, and promote early clinical suspicion of malignancy within this population. Although the framework remains conceptual and requires further validation in clinical practice, it offers a practical reference for routine radiologic assessment. Implementation of such structured methodologies may enhance diagnostic accuracy and enable timely management of lung cancer in never-smoker females, particularly within resource-limited settings.

## Ethical Statement

**Ethical Approval:**

This study is a descriptive methodological framework development and does not involve human participants, patient data, or identifiable information. Therefore, institutional ethics committee approval was not required.

**Acknowledgment**

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**Conflict of Interest**

The author(s) declare that there are no conflicts of interest related to this study.

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