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Determinants of Mediastinal Lymph Node Attenuation on Non-Contrast Chest Computed Tomography

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Abstract:

Objective: To investigate clinical determinants of mediastinal lymph node attenuation (MLNA) on non-contrast chest computed tomography (CT), focusing on smoking history and cardiometabolic factors.

Methods: In this retrospective single-center study, individuals undergoing non-contrast chest CT without known cardiopulmonary disease were included. MLNA was measured in Hounsfield units (HU) from the largest visible mediastinal lymph node. Smoking status (ever vs never), age, sex, hypertension, diabetes mellitus, and body mass index were recorded. Multivariable linear regression identified independent predictors of MLNA. Receiver operating characteristic (ROC) analysis evaluated attenuation for discriminating smoking history.

Results: A total of 138 individuals were analyzed (82 ever smokers, 56 never smokers). MLNA was higher in ever smokers than never smokers (median 39.5 vs 35 HU, P=0.001). In multivariable analysis, smoking history remained independently associated with increased attenuation (B=5.48 HU, 95% confidence interval [CI]: 1.72–9.23, P=0.005). Age (B=0.33 HU/year, P<0.001), hypertension (B=6.55 HU, P=0.009), and diabetes mellitus (B=5.93 HU, P=0.043) were also independent predictors, whereas sex and BMI were not significant. The model explained 41% of attenuation variance (R^2=0.41). ROC analysis demonstrated moderate discrimination for smoking history (area under curve [AUC] = 0.66; optimal cut-off 46 HU, specificity of 89.3%). Attenuation values were highest among current smokers in exploratory analyses.

Conclusion: Smoking history, age, hypertension, and diabetes mellitus are independently associated with increased mediastinal lymph node attenuation on non-contrast CT. Elevated attenuation may reflect chronic inflammatory activation, fibrotic remodeling, and cumulative cardiometabolic tissue injury rather than overt pathology, supporting its role as a contextual imaging marker in risk-aware radiologic interpretation.

Keywords: Mediastinal Lymph Nodes, Computed Tomography, Attenuation, Smoking, Hypertension, Diabetes mellitus

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Mediastinal lymph nodes are routinely evaluated on chest computed tomography (CT) for a wide spectrum of clinical indications, including cancer staging, infection, and incidental findings. Beyond nodal size, morphological characteristics and attenuation values on CT may provide additional information regarding underlying pathological processes such as inflammation, fibrosis, necrosis, or calcification. CT attenuation measurements have therefore been increasingly investigated as potential imaging biomarkers for mediastinal lymph node characterization [1].

High-attenuation lymph nodes on CT are frequently associated with chronic inflammatory conditions, prior granulomatous disease, or occupational exposures such as pneumoconiosis and silicosis, in which calcified mediastinal nodes may develop over time [2]. Chronic inflammatory lung diseases and environmental exposures have also been linked to mediastinal and hilar lymphadenopathy, supporting the concept that nodal structural changes may reflect long-term inflammatory burden [3].

Smoking is a major source of chronic airway inflammation and particulate exposure and has been associated with mediastinal lymph node enlargement and anthracotic nodal changes. Environmental and occupational exposures, including cigarette smoke, have been identified as important contributors to anthracosis and nodal structural alterations on imaging [4]. Previous imaging studies have also demonstrated that mediastinal lymph node changes may be observed in smokers and patients with chronic pulmonary conditions, suggesting a potential relationship between smoking-related inflammatory burden and nodal imaging characteristics.

Despite these observations, the role of CT attenuation in mediastinal lymph nodes remains incompletely understood. Most previous studies have focused on malignant nodal involvement or granulomatous diseases, and attenuation thresholds have not been standardized. CT attenuation has been reported as a potentially useful parameter in differentiating benign from pathological lymph nodes; however, its clinical interpretation remains challenging, particularly in patients without known cardiopulmonary disease.

Furthermore, mediastinal lymph node changes may not be solely related to pulmonary pathology. Systemic factors such as aging, vascular disease, and cardiometabolic conditions may influence tissue remodeling, chronic inflammation, and calcification processes, which could be reflected in nodal attenuation values on CT. However, data evaluating these associations in otherwise healthy individuals undergoing chest CT for non-pulmonary indications are limited. Recent data indicate that incidental mediastinal lymph nodes are frequently encountered in routine chest CT examinations, and their attenuation characteristics may vary according to underlying systemic or environmental factors [5]. Moreover, imaging-based classification systems emphasize that attenuation patterns should be interpreted in conjunction with clinical background, particularly in patients without known malignancy or granulomatous disease [6, 7].

Therefore, the present study aimed to investigate the association between smoking history and mediastinal lymph node attenuation on non-contrast chest CT in individuals without known cardiopulmonary disease. In addition, we sought to evaluate the independent effects of demographic and cardiometabolic factors on nodal attenuation values and to explore the potential discriminative ability of CT attenuation for identifying smoking exposure.

METHODS

Study Design and Population

This retrospective, single-center observational study included randomly selected individuals who underwent non-contrast chest CT for various clinical indications between April 2021 and February 2026. Patients with radiologically evident sequelae of prior tuberculosis, lung malignancy, pneumonia, interstitial lung disease, or established heart failure were excluded. CT examinations acquired at a tube voltage other than 120 kVp were also excluded. In addition, scans with poor image quality were not included in the analysis (Figure 1).

Demographic and clinical data, including age, sex, smoking history, hypertension, diabetes mellitus, and body mass index (BMI), were obtained from electronic medical records. Smoking status was categorized as ever smoker (current or former smoker combined) or never smoker for the primary analyses.

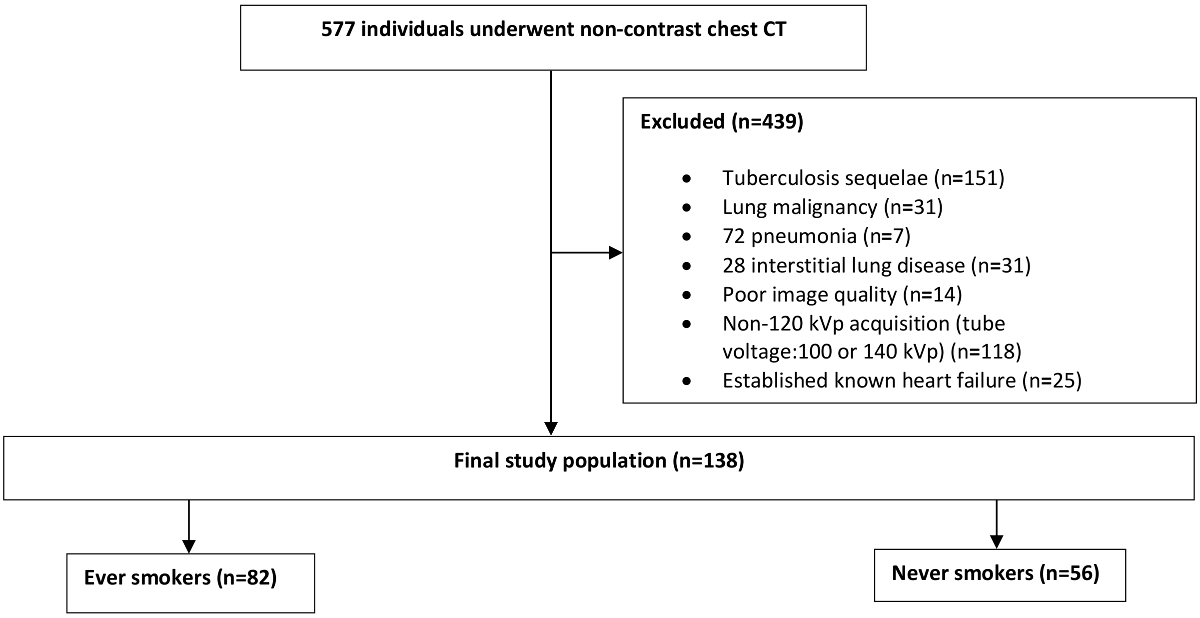

FIGURE 1. Flowchart of the study population.

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Local Ethics Committee on Human Research (approval number 2026.114.IRB2.051; February 26, 2026). The requirement for informed consent was waived due to the retrospective design of the study.

CT Acquisition Protocol

All examinations were obtained using multidetector CT systems (Siemens Somatom Definition Flash and Somatom Definition AS; Siemens Healthineers, Forchheim, Germany) without administration of intravenous contrast material. Scans were performed with patients in the supine position during end-inspiratory breath-hold and with both arms elevated above the head to minimize beam-hardening artifacts. To ensure attenuation consistency, only studies acquired at a tube voltage of 120 kVp were included in the analysis. All attenuation measurements were obtained using standardized mediastinal window settings.

The scan coverage extended from the thoracic inlet to the costophrenic recesses. Image datasets were reconstructed from raw projection data using a medium soft-tissue convolution kernel (e.g., B30f) with thin-section reconstructions (slice thickness and increment 1–1.5 mm) to allow accurate mediastinal lymph node evaluation.

Mediastinal lymph node attenuation (MLNA) values were quantified in Hounsfield unit (HU) by means of circular regions of interest (ROIs) positioned within the nodal parenchyma.

Image Analysis and Attenuation Measurements

Mediastinal lymph nodes were considered eligible for measurement if the short-axis diameter exceeded 5 mm. Among eligible nodes, the largest mediastinal lymph node per patient was selected for quantitative assessment. In the malignancy cohort, only lymph nodes that had undergone surgical dissection or histopathological sampling were included. Short-axis diameter measurements were recorded for all study groups.

Attenuation measurements were performed by a thoracic radiologist with more than ten years of dedicated experience. Circular ROIs were carefully positioned within the solid component of the lymph node, deliberately excluding fatty hila, calcified foci, and partial-volume artifacts. The ROI diameter was adjusted to encompass at least two-thirds of the nodal short-axis dimension in order to obtain representative mean attenuation values. Representative examples of MLNA measurement in smoker and non-smoker individuals are illustrated in Figure 2. All

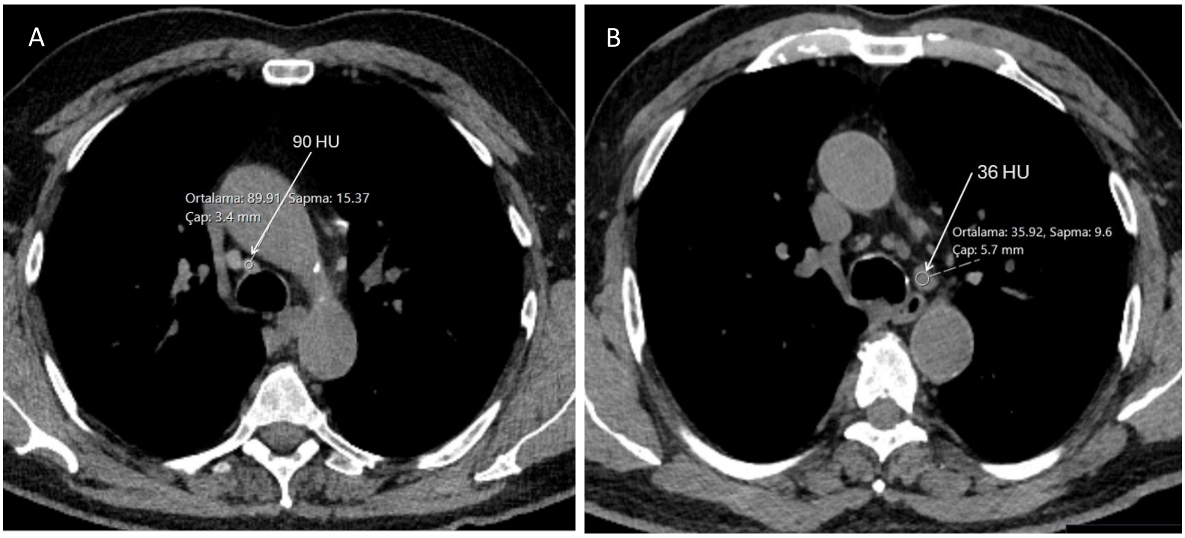

FIGURE 2. Representative examples of mediastinal lymph node attenuation (MLNA) measurements on non-contrast chest CT. Circular regions of interest (ROIs) were positioned within the solid portion of the lymph node while avoiding calcification, fatty hilum, and adjacent structures. (A) Example from a 67-year-old active smoker with diabetes mellitus demonstrating increased attenuation in the 4R lymph node station (90 HU). (B) Example from a never-smoker demonstrating lower attenuation in the 4L lymph node station (36 HU).

measurements were done by the same senior radiologist (ZA) blinded to the history of smoking and cardiometabolic status.

Outcome Measures

The primary outcome of the study was MLNA (HU). The main independent variable of interest was smoking history (ever vs never smoker). Secondary variables included age, sex, hypertension, diabetes mellitus, and BMI.

Statistical Analysis

Continuous variables were tested for normality using the Shapiro–Wilk test and visual inspection of histograms. As attenuation values were not normally distributed, data were expressed as median and interquartile range (IQR), and group comparisons (ever smokers vs never smokers) were performed using the Mann–Whitney U test. Subgroup analysis comparing current smokers, former smokers, and never smokers were performed using the Kruskal–Wallis test followed by post-hoc pairwise comparisons with Bonferroni correction. Multivariable linear regression analysis was conducted to identify independent predictors of mediastinal lymph node attenuation. Variables included in the model were age, sex, hypertension, diabetes mellitus, BMI, and smoking history. Regression coefficients (B), 95% confidence intervals (CI), and P-values were reported. Receiver operating characteristic (ROC) curve analysis was performed to evaluate the discriminative ability of attenuation values for identifying smoking history, and the optimal cut-off value was determined using the Youden index. A two-tailed P-value <0.05 was considered statistically significant. All statistical analyses were performed using SPSS (version 28.0; IBM Corp., Armonk, NY, USA).

RESULTS

A total of 138 individuals were included in the study, comprising 82 ever smokers and 56 never smokers. The mean age of the study population was 51.1±13.1 years, and 42.8% were female. Baseline demographic and clinical characteristics of the study population are summarized in Table 1. Ever smokers were older and had a higher prevalence of hypertension and diabetes compared with never smokers. MLNA values were not normally distributed. Ever smokers had significantly higher attenuation values compared with never smokers (median 39.5 HU [IQR: 34–61.3] vs 35 HU

TABLE 1. Baseline Characteristics and Mediastinal Lymph Node Attenuation of the Study Population

Variable	Ever smokers (n=82)	Never smokers (n=56)	P-value
Age (years)	52.9±12.2	48.4±14.0	**0.045**
Female, n (%)	34 (41.5%)	25 (44.6%)	0.845
BMI (kg/m²)	26.9±5.7	25.9±4.6	0.297
Hypertension, n (%)	29 (35.4%)	12 (21.4%)	0.117
Diabetes mellitus, n (%)	14 (17.1%)	6 (10.7%)	0.426
Mediastinal lymph node attenuation (HU)	39.5 (34–61.3)	35 (32–40)	**0.001**

Data are shownas mean±standard deviation, median (interquartile range), or number (percentage) where appropriate. BMI, body mass index; HU, Hounsfield unit.

Comparisons between groups were performed using Student's t-test for continuous variables with normal distribution, Mann–Whitney U test for non-normally distributed variables, and chi-square test for categorical variables. Ever smokers included both current and former smokers. Statistically significant P-values are shown in bold.

[IQR: 32–40], P=0.001) (Table 1).

As shown in Table 2, smoking history remained independently associated with increased MLNA after adjustment for age, sex, hypertension, diabetes mellitus, and body mass index (B = 5.48 HU, 95% CI: 1.72–9.23, P=0.005). Age was also an independent predictor, with an increase of 0.33 HU per year (95% CI: 0.16–0.49, P<0.001). Hypertension (B = 6.55 HU, 95% CI: 1.69–11.42, P=0.009) and diabetes mellitus (B = 5.93 HU, 95% CI: 0.18–11.67, P=0.043) were independently associated with higher attenuation values. Sex and BMI were not significant predictors. The regression model explained approximately 41% of the variance in attenuation values ($R^2 = 0.41$).

ROC analysis demonstrated moderate discriminative ability of mediastinal lymph node attenuation for identifying smoking history (ever vs never), with an area under the curve (AUC) of 0.66 (Figure 3). An optimal cut-off value of 46 HU yielded a sensitivity of 42.7% and specificity of 89.3%.

In exploratory analyses comparing current smokers, former smokers, and never smokers, attenuation values were highest among current smokers, followed by former smokers and never smokers (P<0.01). However, pairwise comparisons showed that the primary difference was between current and never smokers, while differences involving former smokers were not statistically

TABLE 2. Multivariable Linear Regression Analysis for Predictors of Mediastinal Lymph Node Attenuation

Variable	B (HU)	95% CI	P-value
Age (per year)	0.33	0.16 – 0.49	**<0.001**
Female sex	−2.57	−6.26 – 1.12	0.171
Hypertension	6.55	1.69 – 11.42	**0.009**
Diabetes mellitus	5.93	0.18 – 11.67	**0.043**
BMI	0.07	−0.30 – 0.44	0.721
Smoking history (ever vs never)	5.48	1.72 – 9.23	**0.005**

CI, confidence interval; BMI, body mass index; HU, Hounsfield unit.

Multivariable linear regression model adjusted for age, sex, hypertension, diabetes mellitus, body mass index, and smoking history. $R^2 = 0.41$. B values represent change in mediastinal lymph node attenuation (HU).

Statistically significant P-values are shown in bold.

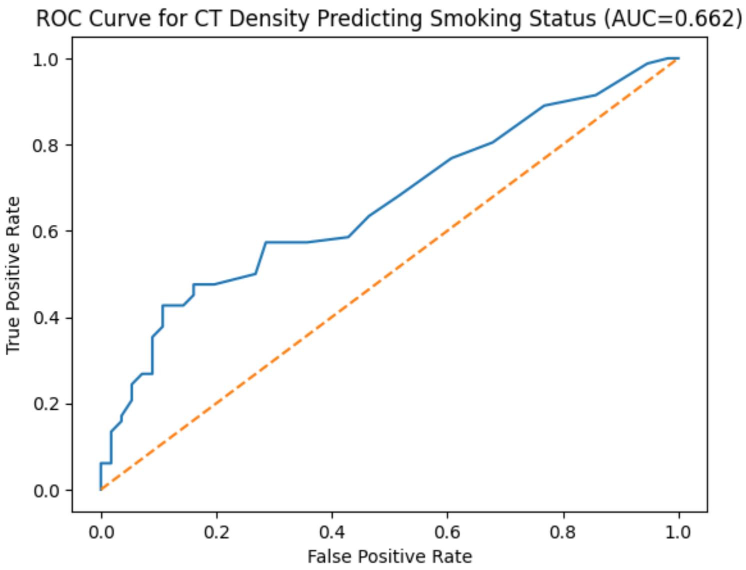

FIGURE 3. Receiver operating characteristic (ROC) curve of mediastinal lymph node attenuation for discriminating ever smokers from never smokers. The area under the curve was 0.66, indicating moderate discriminative performance. A cut-off value of 46 HU provided a sensitivity of 42.7% and specificity of 89.3%.

significant after correction for multiple comparisons (data not shown).

DISCUSSION

In this study, we demonstrated that smoking history was independently associated with increased mediastinal lymph node attenuation on non-contrast chest CT in individuals without known cardiopulmonary disease. Even after adjustment for age, sex, hypertension, diabetes mellitus, and body mass index, smoking history remained a significant predictor of nodal attenuation. These findings suggest that CT attenuation may reflect smoking-related chronic inflammatory or fibrotic nodal alterations.

To our knowledge, this is among the first studies to evaluate mediastinal lymph node attenuation in a non-malignant population while incorporating both environmental exposure and cardiometabolic risk factors in a multivariable framework. Mediastinal lymph node evaluation on CT has traditionally focused on nodal size rather than attenuation characteristics. However, attenuation values may provide additional information regarding underlying tissue composition, including fibrosis, calcification, and inflammatory infiltration. Prior imaging studies have suggested that CT attenuation may assist in lymph node characterization, although no universally accepted threshold has been established [1]. Our findings extend this concept by demonstrating that smoking exposure itself may influence nodal attenuation values, even in the absence of overt pulmonary disease. While several studies have evaluated mediastinal lymph nodes primarily in the context of lung cancer staging using CT and PET/CT, attenuation values alone have not shown sufficient specificity for malignancy discrimination [8-11]. These findings reinforce the need to interpret increased attenuation cautiously, especially in populations with chronic inflammatory exposures such as smoking.

Chronic exposure to cigarette smoke is known to induce persistent airway inflammation, macrophage activation, and deposition of carbonaceous particles within lymphatic tissue. Anthracotic changes in mediastinal lymph nodes have been described in smokers and individuals exposed to environmental pollutants [4]. These structural alterations may increase tissue density and contribute to higher attenuation values on non-contrast CT. In addition, chronic inflammatory stimulation may promote fibrotic remodeling within lymph nodes, further increasing CT attenuation. Radiologic descriptions of high-attenuation thoracic lesions have previously emphasized the role of calcification and chronic inflammatory processes [2], which may represent a similar pathophysiologic pathway. In addition to qualitative descriptions, comparative CT studies have demonstrated that anthracotic lymph nodes may show higher attenuation values compared with non-anthracotic nodes, although significant overlap exists with malignant nodes [12]. FDG-PET/CT studies further support the concept that benign anthracotic lymphadenitis may present with increased metabolic activity and imaging features mimicking malignancy, underscoring the importance of careful radiologic interpretation [13, 14]. Occupational particulate exposure has also been associated with high-attenuation mediastinal lymph nodes due to mineral deposition and chronic inflammatory remodeling [2, 15].

In the present study, age, hypertension, and diabetes mellitus were independently associated with higher mediastinal lymph node attenuation values, suggesting that nodal density may reflect not only smoking-related changes but also broader systemic processes. Aging is known to be accompanied by cumulative inflammatory burden, progressive tissue remodeling, and alterations in lymphatic and vascular structures, which may contribute to increased attenuation over time [16]. Hypertension and diabetes, both components of cardiometabolic disease, are characterized by chronic low-grade inflammation, endothelial dysfunction, and fibrotic remodeling affecting multiple organ systems. These systemic changes may extend to lymphatic tissue and mediastinal nodes, potentially explaining the observed association with increased CT attenuation. Although direct evidence linking these conditions specifically to lymph node attenuation is limited, shared mechanisms such as microvascular alterations and extracellular matrix deposition provide a plausible biological framework for our findings. Microvascular dysfunction and extracellular matrix remodeling in diabetes mellitus have been well documented and may theoretically contribute to increased tissue density in lymphatic structures [16]. Similarly, cardiometabolic inflammation has been proposed as a systemic imaging-relevant phenotype that may manifest across multiple organ systems, including thoracic structures [17].

Importantly, these associations should be interpreted cautiously. Diabetes and hypertension frequently coexist with aging and smoking exposure, and their effects may overlap through common inflammatory and fibrotic pathways. Therefore, increased nodal attenuation in these patients may represent a composite cardiometabolic phenotype rather than disease-specific structural change. Larger studies incorporating metabolic control parameters and longitudinal follow-up are needed to clarify the relative contributions of these factors to mediastinal lymph node attenuation [17].

The ROC analysis demonstrated moderate discriminative ability of mediastinal lymph node attenuation for identifying smoking history (AUC = 0.66). While attenuation alone does not provide sufficient sensitivity to serve as a diagnostic marker of smoking exposure, higher HU thresholds showed relatively high specificity. Therefore, increased nodal attenuation should not be interpreted as a diagnostic test for smoking status; rather, it may represent a supportive imaging feature reflecting chronic exposure-related tissue changes.

From a clinical perspective, incidental mediastinal lymph nodes with relatively high attenuation values on non-contrast CT are commonly encountered in daily radiology practice [18]. Our findings suggest that smoking history should be considered when interpreting such findings, particularly in patients without known malignancy or granulomatous disease. Awareness of this association may reduce unnecessary additional imaging or invasive investigations in selected cases.

Radiographic assessment of mediastinal and hilar lymph nodes in sarcoidosis has demonstrated that nodal morphology and density may vary according to disease stage and fibrotic burden [19].

Case reports have further illustrated that anthracosis may present with mediastinal lymphadenopathy mimicking tuberculosis or malignancy, highlighting the importance of integrating imaging findings with clinical exposure history [20].

Strengths and Limitations

This study has several strengths. First, it provides novel evidence that smoking history is independently associated with mediastinal lymph node attenuation on non-contrast CT in individuals without known cardiopulmonary disease. Second, the study population was carefully selected by excluding patients with overt cardiopulmonary disorders, malignancy, active infection, interstitial lung disease, and other major conditions that could potentially affect mediastinal lymph node morphology or attenuation. Third, the use of non-contrast CT and quantitative attenuation measurements offers a practical and reproducible imaging-based approach that can be easily applied in routine thoracic imaging. In addition, the evaluation of mediastinal lymph nodes in an otherwise clinically selected population may contribute to a better understanding of smoking-related subclinical nodal changes.

However, this study also has several limitations. First, its retrospective and single-center design may limit generalizability. Second, quantitative smoking exposure, such as pack-years, and duration since smoking cessation were not available, preventing dose–response analysis. Third, histopathologic correlation was not performed, and attenuation values were used as a surrogate imaging biomarker of structural nodal change. In addition, incidental subclinical granulomatous exposure or occult anthracotic changes may still have contributed to mediastinal lymph node attenuation despite the exclusion of overt cardiopulmonary disease. Finally, interobserver variability was not assessed, which may influence measurement reproducibility. Future prospective studies incorporating quantitative smoking exposure, longitudinal follow-up, and histopathologic correlation are warranted to further clarify the biological basis of these imaging findings.

CONCLUSION

Smoking history is independently associated with increased mediastinal lymph node attenuation on non-contrast chest CT in individuals without known cardiopulmonary disease. Age, hypertension, and diabetes mellitus were also identified as independent contributors to higher nodal attenuation values, suggesting that mediastinal lymph node density may reflect cumulative inflammatory and cardiometabolic remodeling rather than solely overt pathological processes. These findings indicate that elevated nodal attenuation—particularly in patients with a history of smoking or cardiometabolic risk factors—may represent chronic exposure-related inflammatory and fibrotic changes rather than malignancy or granulomatous disease. In routine radiologic practice, incidental mediastinal lymph nodes with increased attenuation should therefore be interpreted within the clinical context. Incorporating patient history into image assessment may enhance diagnostic confidence, reduce unnecessary additional imaging or invasive procedures, and support more individualized, context-based decision-making. Accordingly, CT attenuation should be considered a complementary imaging marker of chronic exposure and systemic inflammatory burden rather than a standalone indicator of disease.

Ethics Approval and Consent to Participate

This study was approved by the Koc University Biomedical Research Ethics Committee. (Decision No: 2026.114.IRB2.051; date: 26.02.2026). All procedures were conducted in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments. The requirement for informed consent was waived due to the retrospective design of the study.

Data Availability

Data collected for the study, including de-identified individual participant data, will be made available within 6 months after the publication of this article for academic purposes, such as meta-analyses, upon reasonable request to the corresponding author and with a signed data access agreement.

Authors' Contribution

Study Conception: ZA, YP; Study Design: ZA, YP; Supervision: YP; Funding: N/A; Materials: N/A, TT; Data Collection and/or Processing: ZA, EC, TT; Statistical Analysis and/or Data Interpretation: ZA, YP; Literature Review: ZA; Manuscript Preparation: ZA, YP; and Critical Review: EC.

Conflict of Interest

The author(s) disclosed no conflict of interest during the preparation or publication of this manuscript.

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Generative Artificial Intelligence Statement

During the preparation of this manuscript, the authors used ChatGPT (OpenAI) solely to improve language, grammar, and readability. The authors reviewed and edited the content as needed and take full responsibility for the accuracy, integrity, and scientific content of the publication. All study content, including study design, data collection, image analysis, statistical interpretation, and scientific conclusions, was produced by the authors in accordance with scientific research methods and academic ethical principles.

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REFERENCES

1. Wang ZL, Yan Y, Li XT, Li YL, Li ZW, Sun YS. Usefulness of attenuation value on computed tomography plain scan for diagnosing enlarged mediastinal lymph nodes metastases. Quant Imaging Med Surg. 2023;13(9):5759-5769. doi: 10.21037/qims-22-1305.
2. Ceylan N, Bayraktaroglu S, Savaş R, Alper H. CT findings of high-attenuation pulmonary abnormalities. Insights Imaging. 2010;1(4):287-292. doi: 10.1007/s13244-010-0039-2.
Ceylan N, Bayraktaroglu S, Savaş R, Alper H. CT findings of high-attenuation pulmonary abnormalities. Insights Imaging. 2010 ;1(4):287-292. doi: 10.1007/s13244-010-0039-2.
3. Suwatanapongched T, Gierada DS. CT of thoracic lymph nodes. Part I: anatomy and drainage. Br J Radiol. 2006;79(947):922-928. doi: 10.1259/bjr/26411607.
4. Tertemiz KC, Güler N, Alpaydın AÖ, Karaçam V, Özdoğan Ö, Ulukuş Ç. F-18 FDG PET/CT findings of intrathoracic lymphadenopathy in EBUS-TBNA-proven anthracosis. Tuberk Toraks. 2022;70(4):305-312. English. doi: 10.5578/tt.20229601.
5. Frank L, Quint LE. Chest CT incidentalomas: thyroid lesions, enlarged mediastinal lymph nodes, and lung nodules. Cancer Imaging. 2012;12(1):41-48. doi: 10.1102/1470-7330.2012.0006.
6. Roy SG, Digumarthy SR. Imaging Evaluation of Mediastinal and Hilar Lymphadenopathy: Approach, Classification, and Differential Diagnosis. Semin Roentgenol. 2025;60(2):105-122. doi: 10.1053/j.ro.2025.02.007.
7. Ganeshalingam S, Koh DM. Nodal staging. Cancer Imaging. 2009;9(1):104-111. doi: 10.1102/1470-7330.2009.0017.
8. Yoo SY, Kim Y, Cho HH, et al. Dual-energy CT in the assessment of mediastinal lymph nodes: comparative study of virtual non-contrast and true non-contrast images. Korean J Radiol. 2013;14(3):53239-9. doi: 10.3348/kjr.2013.14.3.532.
9. Damirov F, Büsing K, Yavuz G, et al. Preoperative Hilar and Mediastinal Lymph Node Staging in Patients with Suspected or Diagnosed Lung Cancer: Accuracy of 18F-FDG-PET/CT:A Retrospective Cohort Study of 138 Patients. Diagnostics (Basel). 2023;13(3):403. doi: 10.3390/diagnostics13030403.
10. Jeon TY, Lee KS, Yi CA, et al. Incremental value of PET/CT Over CT for mediastinal nodal staging of non-small cell lung cancer: Comparison between patients with and without idiopathic pulmonary fibrosis. AJR Am J Roentgenol. 2010;195(2):370-376. doi: 10.2214/AJR.09.3772.
11. Shiraishi S, Tomiguchi S, Utsunomiya D, et al. Quantitative analysis and effect of attenuation correction on lymph node staging of non-small cell lung cancer on SPECT and CT. AJR Am J Roentgenol. 2006;186(5):1450-1457. doi: 10.2214/AJR.04.0898.
12. Kirchner J, Broll M, Müller P, et al. CT differentiation of enlarged mediastinal lymph node due to anthracosis from metastatic lymphadenopathy: a comparative study proven by endobronchial US-guided transbronchial needle aspiration. Diagn Interv Radiol. 2015;21(2):128-133. doi: 10.5152/dir.2014.14112.
13. Hewitt RJ, Wright C, Adeboyeku D, et al. Primary nodal anthracosis identified by EBUS-TBNA as a cause of FDG PET/CT positive mediastinal lymphadenopathy. Respir Med Case Rep. 2013;10:48-52. doi: 10.1016/j.rmcr.2013.09.005.
14. Giri S, Kumar L, Mane K, Uppin MS, Bhrugumalla S, Sundaram S. 18F-Fluorodeoxyglucose-Avid Benign Anthracotic Mediastinal Lymphadenitis Mimicking Metastatic Lymphadenopathy. Cureus. 2024;16(5):e59614. doi: 10.7759/cureus.59614.
15. Vahlensieck M, Overlack A, Müller KM. Computed tomographic high-attenuation mediastinal lymph nodes after aluminum exposition. Eur Radiol. 2000;10(12):1945-1946. doi: 10.1007/s003300000534.
16. Jan YK, Kelhofer N, Tu T, et al. Diagnosis, Pathophysiology and Management of Microvascular Dysfunction in Diabetes Mellitus. Diagnostics (Basel). 2024;14(24):2830. doi: 10.3390/diagnostics14242830.
17. Tahir UA, Gerszten RE. Molecular Biomarkers for Cardiometabolic Disease: Risk Assessment in Young Individuals. Circ Res. 2023;132(12):1663-1673. doi: 10.1161/CIRCRESAHA.123.322000.
18. Kużdżał A, Kużdżał B, Moszczyński K, et al. PET-CT in mediastinal staging of non-small cell lung cancer: analysis of false results. Pol J Radiol. 2025;90:e234-e238. doi: 10.5114/pjr/202315.
19. Ayçiçek O, Bülbül Y, Öztuna F, Özlu T, Akkaya S. Diagnostic Value of Radiographic Characteristics of Mediastinal and Hilar

Lymph Nodes in Sarcoidosis. Turk Thorac J. 2022;23(4):284-289. doi: 10.5152/TurkThoracJ.2022.21254.
20. Bilici A, Erdem T, Boysan SN, Acbay O, Oz B, Besirli K, Gundogdu S. A case of anthracosis presenting with mediastinal lymph nodes mimicking tuberculous lymphadenitis or malignancy. Eur J Intern Med. 2003;14(7):444-446. doi: 10.1016/j.ejim.2003.09.001.