TPM Vol. 32, No. S5, 2025
ISSN: 1972-6325
https://www.tpmap.org/

COMPARATIVE ANALYSIS OF THE CARDIOTHORACIC RATIO IN CHEST X-RAY BETWEEN SMOKERS AND NON – SMOKERS

ABRAHAM J[1], ASHIQ BASHA A[1], RAMNATH V[1]
[1]MEENAKSHI COLLEGE OF ALLIED HEALTH SCIENCES, MEENAKSHI ACADEMY OF HIGHER EDUCATION AND RESEARCH (MAHER) DEEMED TO BE UNIVERSITY, TAMIL NADU, INDIA

PRAVEENKUMAR S[2], SASIDHARAN S[2*]
[2]DEPARTMENT OF RADIOLOGY AND IMAGING SCIENCES, MEENAKSHI MEDICAL COLLEGE HOSPITAL AND RESEARCH INSTITUTE (MMCHRI), MEENAKSHI ACADEMY OF HIGHER EDUCATION AND RESEARCH (MAHER) DEEMED TO BE UNIVERSITY, TAMIL NADU, INDIA.

ABSTRACT
Smoking is a well-established risk factor for cardiovascular and pulmonary diseases. Chronic tobacco use may lead to structural alterations in the heart and thoracic cavity, potentially manifesting as an increased cardiothoracic ratio (CTR) on chest radiographs. The CTR, a widely used radiological parameter, provides a non-invasive method to screen for cardiomegaly. This study aims to investigate whether a significant difference in CTR exists between smokers and non-smokers. To compare the cardiothoracic ratio observed in chest X-rays between smokers and non- smokers and to determine the prevalence of cardiomegaly in each group. A Prospective cross-sectional study will be conducted using posteroanterior (PA) chest X- rays from adults aged 18–75 years. Participants will becategorized into smokers (current or former)andnon-smokers (never smoked or minimal exposure) based on medical history. The CTR will be calculated by dividing the maximum transverse cardiac diameter by the internal thoracic diameter. Data will be analyzed using independent t-tests and chi-square tests to assess statistical significance, with a p-value < 0.05 considered significant. It is anticipated that smokers will exhibit a higher mean CTR compared to non-smokers, with a greater proportion exceeding the threshold value of 0.50, indicating a higher prevalence of cardiomegaly. These findings are expected to support the hypothesis that smoking contributes to adverse structural cardiac changes detectable on routine chest radiographs. This study highlights a potential association between smoking and increased cardiothoracic ratio (CTR), suggesting that chronic tobacco use may contribute to structural cardiac changes detectable on chest radiographs.

INTRODUCTION

The cardiothoracic ratio (CTR), defined as the ratio of the maximum horizontal cardiac diameter to the maximum horizontal thoracic diameter on a chest X-ray (CXR), serves as a fundamental parameter in assessing cardiovascular and pulmonary health. An abnormal CTR has been associated with several pathologies, such as cardiomegaly, heart failure, and pulmonary diseases, which may be exacerbated by lifestyle factors such as smoking.

This study aims to conduct a comparative analysis of the cardiothoracic ratio between smokers and non-smokers using chest X-ray imaging, providing insight into the potential alterations in cardiac morphology induced by smoking and its pathological consequences. Understanding the impact of smoking on the cardiothoracic ratio is crucial for early diagnosis, intervention, and prevention of smoking-related cardiovascular diseases. Smoking, on the other hand, is an established major risk factor for a multitude of cardiovascular diseases (CVDs). The World Health Organization estimates that tobacco use is responsible for more than 8 million deaths each year, a significant portion of which are due to cardiovascular complications. The deleterious effects of smoking on the cardiovascular system are well documented and include endothelial dysfunction, increased oxidative stress, chronic inflammation, and acceleration of atherosclerotic processes. Nicotine and other harmful substances in tobacco smoke exert direct and indirect effects on the heart and blood vessels, increasing the risk of conditions such as coronary artery disease, hypertension, myocardial infarction, and congestive heart failure.

Given that the structural and functional changes in the heart induced by smoking can manifest as an increase in cardiac size, it becomes pertinent to investigate whether smokers exhibit a higher cardiothoracic ratio compared to non-smokers. Several studies have highlighted the impact of smoking on left ventricular hypertrophy, cardiac remodeling, and heart failure, but there remains a need for more population-based studies that use simple diagnostic tools such as chest X-rays to observe such effects in different demographic groups.

A comparative analysis of CTR in smokers and non-smokers can serve multiple purposes. Firstly, it can help in early detection of subclinical cardiac enlargement in asymptomatic individuals, especially in primary healthcare settings. Secondly, it can reinforce the importance of smoking cessation by providing tangible evidence of the structural impact of smoking on the heart. Thirdly, such studies can help guide public health interventions by identifying high-risk groups who may benefit from more intensive cardiovascular monitoring and preventive

strategies.
This study therefore aims to compare the cardiothoracic ratio in chest X-rays of smokers and non-smokers to explore whether there is a significant difference in cardiac size between these two groups. By doing so, it seeks to contribute to the growing body of evidence regarding the cardiovascular consequences of smoking. The findings of this comparative analysis may also encourage healthcare professionals to utilize routine chest radiography more proactively in the assessment of cardiac health, especially in smokers who may otherwise not undergo regular cardiac evaluations.
In summary, understanding the relationship between smoking and cardiothoracic ratio not only aids in clinical assessment but also underscores the broader public health message about the harmful impact of tobacco use on cardiovascular health. Early detection and intervention remain the cornerstone of reducing smoking-related morbidity and mortality, and simple tools like the CTR can play a significant role in this regard.

AIM

To analysis the cardiothoracic ratio between smokers and non-smokers.

OBJECTIVES

- The objective of this study is to compare the cardiothoracic ratio (CTR) observed in chest X-rays between smokers and non-smokers in order to assess whether smoking has a measurable effect on heart size.
- The study also aims to explore the relationship between the duration of smoking and changes in CTR, contributing to early identification of potential cardiovascular risks associated with smoking.

MATERIALS

EQUIPMENT

GEMEDICALSYSTEMDX525/S (500mA)

METHODOLOGY

STUDYTYPE : Prospective

STUDYDESIGN : Cross sectional Study

STUDYAREA : Department of Radiology & Imaging Sciences, MMCH&RI

SAMPLE SIZE : 60
STUDYPERIOD : 3Months
STUDYPOPULATION:
INCLUSIONCRITERIA:

Adults aged18 years and above, Participants classified clearly as smokers or non- smokers and Chest X-rays of adequate quality for accurate CTR measurement.

EXCLUSION CRITERIA:

Individuals with known cardiac conditions (e.g., cardiomegaly, heart failure, congenital heart disease), Presence of thoracic deformities (e.g., scoliosis, pectus excavatum) or severe kyphosis affecting X-ray interpretation, Patients with pulmonary pathologies (e.g., lungmass, pleural effusion, COPD)that maydistort thoracic anatomy, Chest X-rays that are not in the PA view or of poor technical quality (e.g., rotated, underexposed) and Surgery

METHOD

The study was approved by the institutional ethics committee and an informed signed consent form was obtained from each patient. This prospective study was performed between April 2025 to May 2025. A total of 60 patients were enrolled in this study. The identity of every patient was checked prior to ultrasound examination. They were asked to change to hospital apron and a brief explanation about the procedure to be performed was given to each patient.

Smoking Categories:

1. **Current Smokers:** Individuals who are actively smoking tobacco products (cigarettes, bidis, etc.) at the time of the study or have smoked regularly with in the past 90 days.
2. **Former Smokers (Ex-Smokers):** Individuals who have a history of regular smoking (daily or almost daily) but have quit smoking for more than 30 days prior to the study.
3. **Chain Smokers (Heavy Smokers):** A subset of current smokers who smoke multiple cigarettes or tobacco units continuously throughout the day, typically consuming more than 15 cigarettes per day. This group will be considered in a sub-analysis due to the intensity of exposure.
4. **Occasional/Light Smokers:** Individuals who smoke infrequently or socially (less than 5 cigarettes per day), but not daily.
5. **Non-Smokers:** Individuals who have never smoked or had only minimal, experimental exposure (e.g., tried smoking a few times without adopting the habit).

Radiographic Technique
Standard Posteroanterior (PA) chest radiographs were obtained with the patient in an upright position during full inspiration, using a source-to-image distance (SID) of 180 cm. The cardiothoracic ratio (CTR) was calculated by measuring:

- Maximum transverse cardiac diameter
- Maximum internal thoracic diameter (inner edge of ribs).

CTR = Cardiac Diameter / Thoracic Diameter.
ACTR>0.50was consideredradiographiccardiomegaly.

STATISTICALANALYSIS

All collected data were compiled in Microsoft Excel and analysed using basic statistical tools. The mean cardiothoracic ratio (CTR) was calculated for each group (non- smokers, former, occasional, current, and chain smokers). The prevalence of cardiomegaly (CTR>0.50) was also computed for each group. An independent sample t-Test was used to compare the mean CTR between smokers and non-smokers. AChi-square test was applied to compare the prevalence of cardiomegaly between groups. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 60 adult patients (37 males and 23 females) were included in this prospective cross-sectional study. The age range of the participants was between 18 and 75 years. Clinical presentations varied, with the most common complaints being fever (n
=11), chest pain (n=11), and breathlessness (n=8). Sixteen individuals underwent chest X-ray as part of Master Health Checkups.

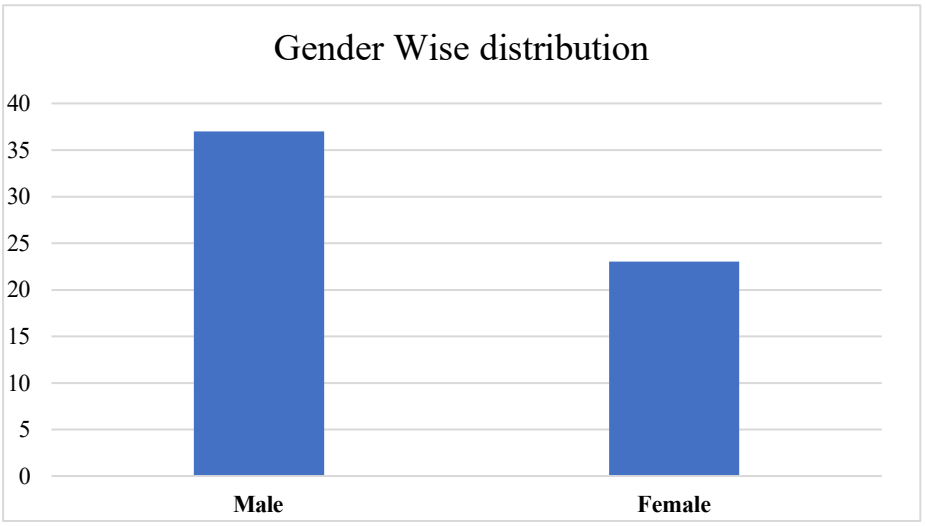
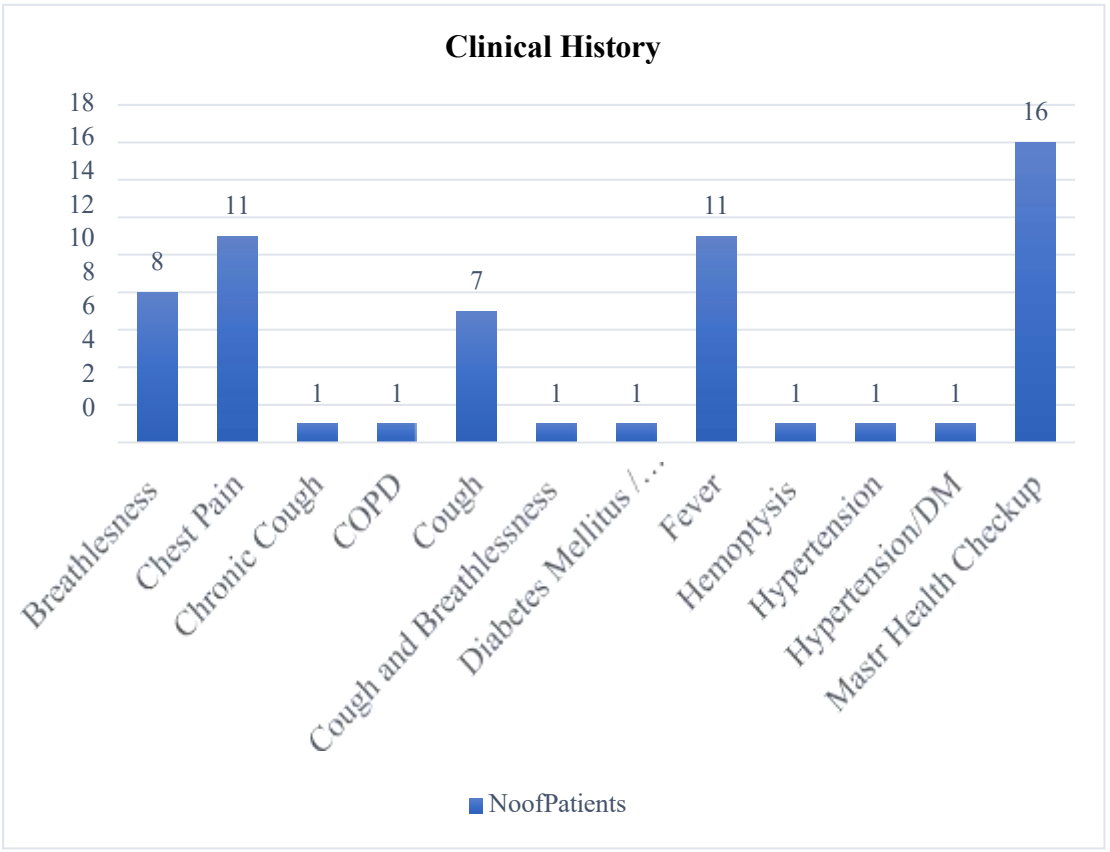


Figure3.1: Shows the Gender Wise Distribution

Smoking Status Distribution

Out of the 60 patients:

- **24(40%)** were non-smokers
- **6(10%)** were former smokers
- **11(18.3%)** were occasional smokers
- **7(11.7%)** were chain smokers
- **12(20%)** were current smokers



- **Figure3.2:** Shows the Distribution of Known clinical con

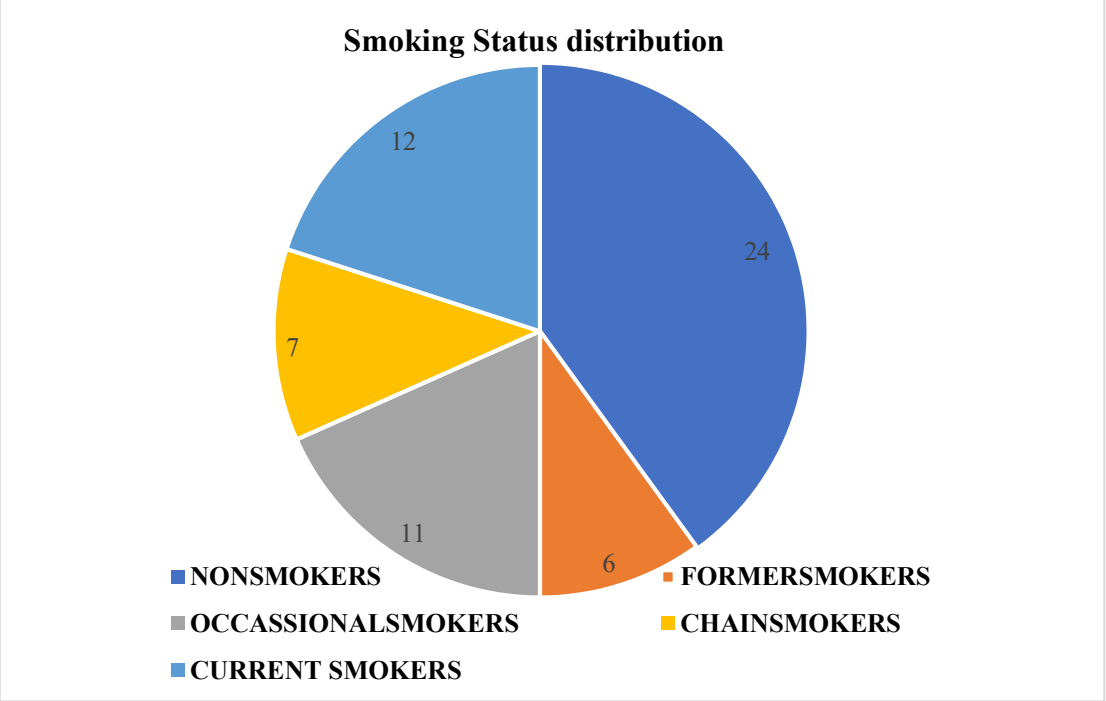


Figure 3.3: Shows the classification of smokers

Cardiothoracic Ratio (CTR)

The number of cases with increased cardiothoracic ratio (CTR>0.50), indicative of cardiomegaly, was:
- **0/24(0%)** among non-smokers
- **3/6(50%)** among former smokers
- **0/11(0%)** among occasional smokers
- **7/7(100%)** among chain smokers
- **7/12(58.3%)** among current smokers

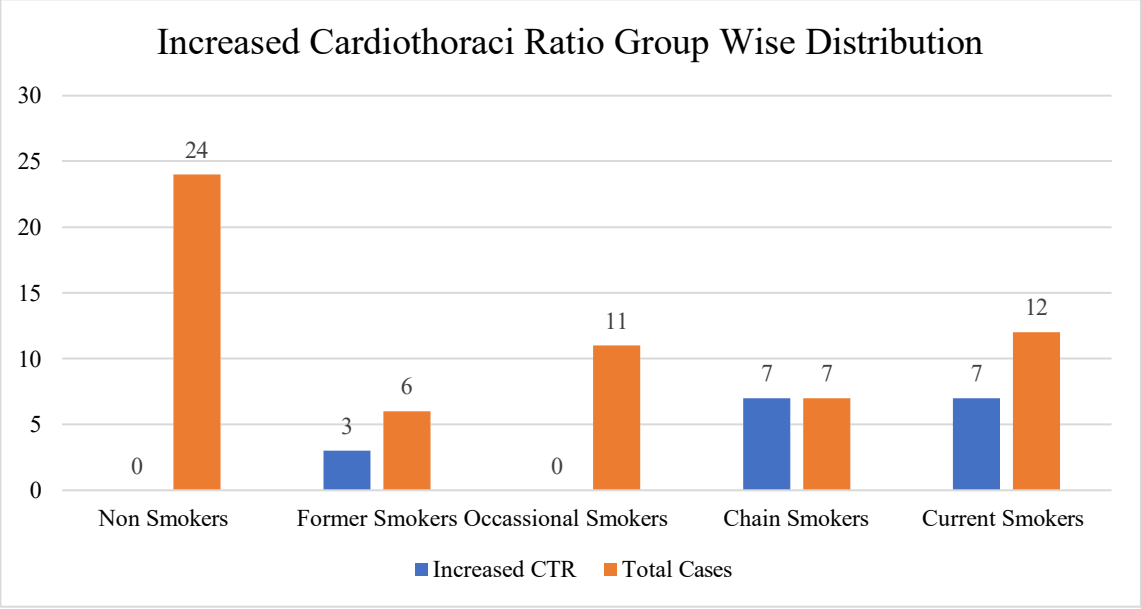


Figure3.4: Shows the Distribution of cases

Figure3.5: Shows the bar graph showing the Mean Cardiothoracic Ratio (CTR)f or each smoking group

Figure3.6: Shows Correlation between smoking status and CTR

A Pearson correlation analysis was performed to assess the relationship between smoking status (quantified using a smoking score from 0 to 4) and the cardiothoracic ratio (CTR). The analysis revealed a moderate positive correlation with a Pearson correlation coefficient (r) of 0.478**,** indicating that as the intensity of smoking increases, there is a corresponding increase in CTR. The correlation was found to be statistically significant ($p < 0.001$)**,** suggesting a meaningful association between chronic tobacco exposure and structural cardiac changes evident on chest radiographs.

Figure 4.1: Shows the normal chest x-ray with CTR –0.43 (Non Smoker)

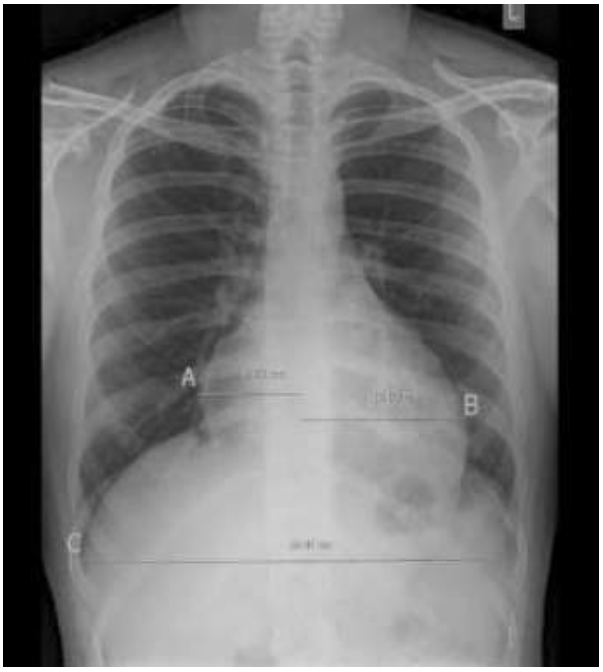


Figure 4.2: Shows the normal chest x-ray with CTR –0.45 (Occasional Smoker)

Figure4.3: Chest X-ray Shows cardiomegaly with CTR–0.53(Current Smoker)

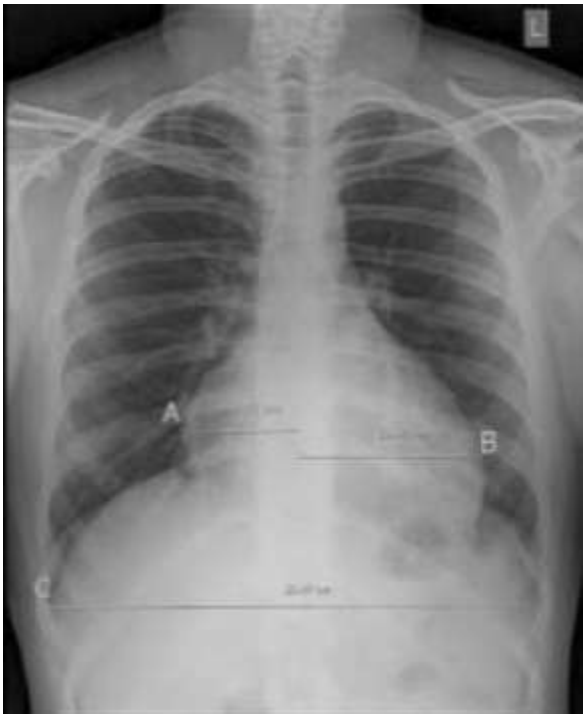


Figure4.4: Chest X-ray shows cardiomegaly with C TR–0.57(Chain Smoker)

DISCUSSION

This study aimed to evaluate the association between smoking status and the cardiothoracic ratio (CTR) observed in chest X-rays. The findings strongly suggest that chronic and intensive smoking is associated with an increased CTR, a key radiographic indicator of cardiomegaly.

Key Observations:

- None of the non-smokers or occasional smokers exhibited an increased CTR.
- A 50% prevalence of cardiomegaly was found among former smokers, which may reflect lasting cardiac effects even after smoking cessation.

- All chain smokers (100%) demonstrated cardiomegaly, indicating a clear cumulative dose effect.
- Among current smokers, 58.3% had increased CTR, suggesting ongoing cardiac stress or damage.

A Chi-square test of independence was performed to assess the relationship between smoking status and increased CTR. The test yielded χ^2 value of 38.25with 4 degrees of freedom, and a p-value of 9.95×10^{-8}. This result is highly statistically significant ($p < 0.000001$), indicating a strong association between smoking and cardiomegaly. Thus, the probability that this observed pattern occurred by chance is extremely low. An increased CTR (>0.50) is often an early radiological sign of cardiac enlargement, which may result from conditions like left ventricular hypertrophy, dilated cardiomyopathy, or chronic pressure overload. Smoking is known to contribute to vascular stiffness, myocardial remodelling, and increased cardiac workload, all of which may lead to cardiac structural changes visible as an elevated CTR on chest X-rays. The statistically significant findings in this study reinforce the role of smoking as a modifiable risk factor in cardiac disease, detectable through a simple, non-invasive tool like a chest radiograph.

Implications:

These findings highlight:

- The utility of routine chest X-rays in identifying at-risk individuals.
- The need for preventive cardiovascular screening among smokers, especially those with long-term or heavy use.
- The urgency of smoking cessation to possibly halt or reverse subclinical cardiac changes.

Limitations:

- The study involved a modest sample size from a single center, which may limit generalizability.
- The CTR was not confirmed with echocardiography or cardiac MRI, which are more specific for assessing structural heart changes.
- Potential confounding factors like hypertension, diabetes, alcohol use, and BMI were not controlled in this analysis.

CONCLUSION:

This study demonstrates a significant association between smoking and increased cardiothoracic ratio (CTR) on chest X-rays, with a notably higher prevalence of cardiomegaly among current and chain smokers. In contrast, non-smokers and occasional smokers showed no evidence of increased CTR. The results were found to be statistically significant ($\chi^2 = 38.25$, $p<0.000001$), supporting the hypothesis that smoking contributes to adverse structural changes in the heart, detectable through routine radiographic screening.

REFERENCE

1. ECG Changesin Smokers and NonSmokers-AComparative Study
2. MRR enuka Devi, TArvind , PSai Kumar.
3. ComparativeStudyofPulmonaryFunctionTestsinSmokersand Non-Smokers- Anand Mistry, Rajula Tyagi, Jaydeep Kagathara, Lopa Vaidya, Urja Dholakiya, Chirag Shah.
4. CardioRespiratoryEfficiencyParameterBetweentheSmokersandNon-Smokers
5. -A Comparative StudyNitai Biswas,RajKumar Maity,KetulKumar,Prof.Dilip Kumar Dureha
6. Differences in cardiovascular mortality in smokers, past-smokers and non- smokerspanelJ.M. Suriñach , L.R. Álvarez , R. Coll ,J.A. Carmona , C. Sanclem ente , E. Aguilar , M. Monreal , FRENA Investigators
7. Cigarettesmokingas a risk factor for coronary heart disease inwomen compared with men - a systematic reviewand meta-analysisofprospectivecohortstudiesRRHuxley,MWoodward- The Lancet,
8. A Study to Compare The Cardiovascular Disease (CVD) Risk Associated with Smokeless Tobacco Consumption and Smoking - SaritaAhwal, Gaddam Rachel Andrews, Ambuj Roy, R. Lakshmy
9. Airway Wall Thickness in Cigarette Smokers - Quantitative Thin-Section CTAssessment - Patrick Berger,Vincent Perot,Pascal Desbarats,José ManuelTunon-de-Lara, Roger Marthan, François Laurent
10. Cardiovascular Mortality and Exposure toAirborne Fine Particulate Matter and Cigarette Smoke -Shape of the Exposure-Response Relationship C.ArdenPope,III, PhD,Richard
11. T.Burnett,PhD,DanielKrewski,PhD,MichaelJerrett,PhD,YuanliShi,MD,Eugenia E. Calle, PhD, and Michael J. Thun, MD
12. Comparisonoftestsusedtodistinguishsmokersfromnonsmokers-MJJarvis,HTunstall-Pedoe,C Feyerabend, C Vesey, and Y Saloojee
13. Respiratory failure in COVID-19 patients a comparative study of smokers to nonsmokers - Mohammad Kharabsheh, Shadi Banitaan , Hakam W. Alomari , Mohammad Alshirah , Sukaina Alzyoud.