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Comparison of Chest Expansion Values Among Smokers and Non-Smokers: An Observational Study

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Abstract

Background: Chest expansion is an indirect but clinically relevant indicator of thoracic mobility and pulmonary function. Cigarette smoking adversely affects lung compliance, airway resistance, and respiratory muscle performance, which may reduce chest expansion even in young adults.
Objective: To compare chest expansion values at different thoracic levels between adult smokers and non-smokers.
Methods: A cross-sectional observational study was conducted on 120 adults aged 20–40 years, recruited through convenience sampling at Parul University, Vadodara. Participants were categorized as smokers (n = 58) and non-smokers (n = 62). Chest expansion was measured using a cloth tape measure at three anatomical levels—axillary, nipple, and xiphisternal—during maximal inspiration and expiration. Mean values were compared between groups using appropriate descriptive and inferential statistics.
Results: Non-smokers demonstrated greater chest expansion at all measured levels compared with smokers. The difference was statistically significant at the nipple and xiphisternal levels ($p < 0.001$), while axillary-level differences showed a smaller but meaningful reduction in smokers. These findings indicate reduced thoracic mobility among smokers even in early adulthood.
Conclusion: Smoking is associated with a significant reduction in chest expansion, reflecting impaired thoracic mobility and respiratory mechanics. Early identification of reduced chest expansion in smokers may help guide preventive and rehabilitative physiotherapy interventions.

Introduction

Smoking remains one of the most significant modifiable risk factors affecting respiratory health worldwide **[6,7]**. Early initiation of smoking, particularly during adolescence and young adulthood, interferes with normal lung growth and accelerates decline in pulmonary function **[6]**. Structural and functional alterations in the respiratory system—including airway inflammation, mucus hypersecretion, alveolar damage, and reduced lung elasticity—are well

documented consequences of cigarette smoking **[5,10]**.

Chest expansion represents the combined effect of lung compliance, airway patency, and respiratory muscle efficiency **[11]**. Reduced chest expansion indicates restricted thoracic mobility and compromised ventilatory capacity. While spirometry is considered the gold standard for pulmonary function assessment, it is not always feasible in routine clinical settings. Cloth tape measurement of chest expansion is a simple, non-invasive, and cost-effective alternative commonly used by physiotherapists **[3,8]**.

Previous studies have demonstrated reduced chest expansion and respiratory muscle strength among smokers compared with non-smokers **[1,4]**. However, limited Indian data exist focusing on young adults using simple clinical measures. Understanding early functional changes is essential for preventive strategies and physiotherapy planning. Therefore, this study aimed to compare chest expansion values among smokers and non-smokers aged 20–40 years.

Methodology

Study Design

A cross-sectional observational study

Study Setting

Study was conducted at Parul Institute of Physiotherapy, Parul University, Vadodara, India.

Participants

A total of 120 participants (63 males, 57 females) aged 20–40 years were recruited through convenience sampling.

Inclusion Criteria

- Adults aged 20–40 years
- Smokers and non-smokers
- Willingness to participate and provide informed consent

Exclusion Criteria

- History of chest trauma or fracture
- Diagnosed chronic respiratory diseases (e.g., COPD, asthma)
- Passive smokers
- Mixed smoking history (recent cessation)
- Chest wall deformities or significant occupational exposure

Sample Size Calculation

A total sample size of 120 participants was included in the study, with subjects divided into smokers (n = 58) and non-smokers (n = 62). Sample size estimation for comparison of two independent means was based on the formula:

$n = 2 \times (Z\alpha + Z\beta)^2 \times \sigma^2 / d^2$

Where $Z\alpha = 1.96$ at a 5% significance level (two-tailed) and $Z\beta = 1.28$ for 90% power. Level of significance was set at $p < 0.05$.

Convenience sampling method was used for participant selection.

Outcome Measure

Chest expansion was measured using a non-elastic cloth tape measure at three anatomical landmarks:

1. Axillary level (upper thorax)
2. Nipple level (mid-thorax)
3. Xiphisternal level (lower thorax)

Measurements were recorded as the difference between maximal inspiration and maximal expiration. Three trials were performed at each level, and the average value was used for analysis.

Procedure

Participants were assessed in a relaxed sitting position with minimal clothing. The tape was applied horizontally and snugly without compressing the chest wall. Standardized verbal instructions were provided to ensure maximal effort during inspiration and expiration.

Statistical Analysis

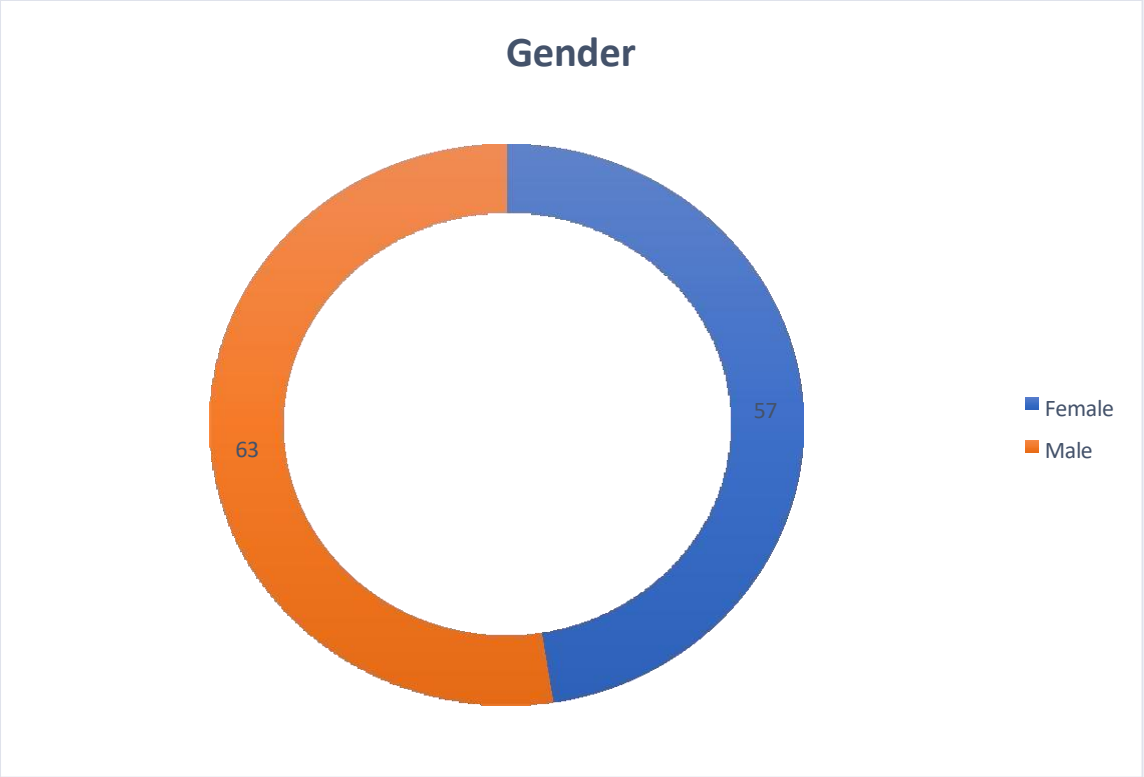
Data were analyzed using IBM SPSS version 27.0. Descriptive statistics were expressed as mean ± standard deviation. Group comparisons were performed using appropriate parametric or non-parametric tests based on data distribution. Statistical significance was set at $p < 0.05$.

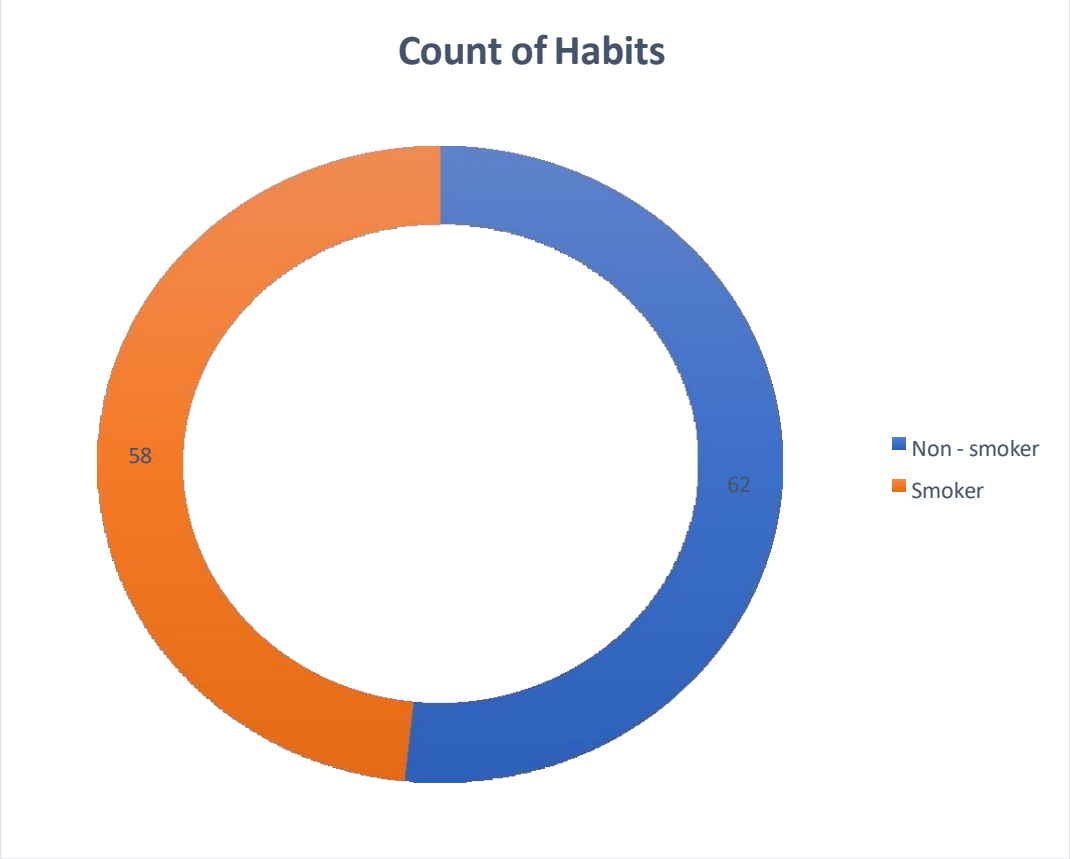
Result

The study included 58 smokers and 62 non-smokers. Mean chest expansion values were consistently higher in non-smokers at all three thoracic levels.

- **Axillary level:** Smokers showed reduced expansion compared to non-smokers.
- **Nipple level:** A statistically significant reduction in smokers ($p < 0.001$).
- **Xiphisternal level:** Markedly lower chest expansion in smokers ($p < 0.001$).

These findings demonstrate restricted thoracic mobility among smokers despite their relatively young age.


Gender
57
63
Female
Male

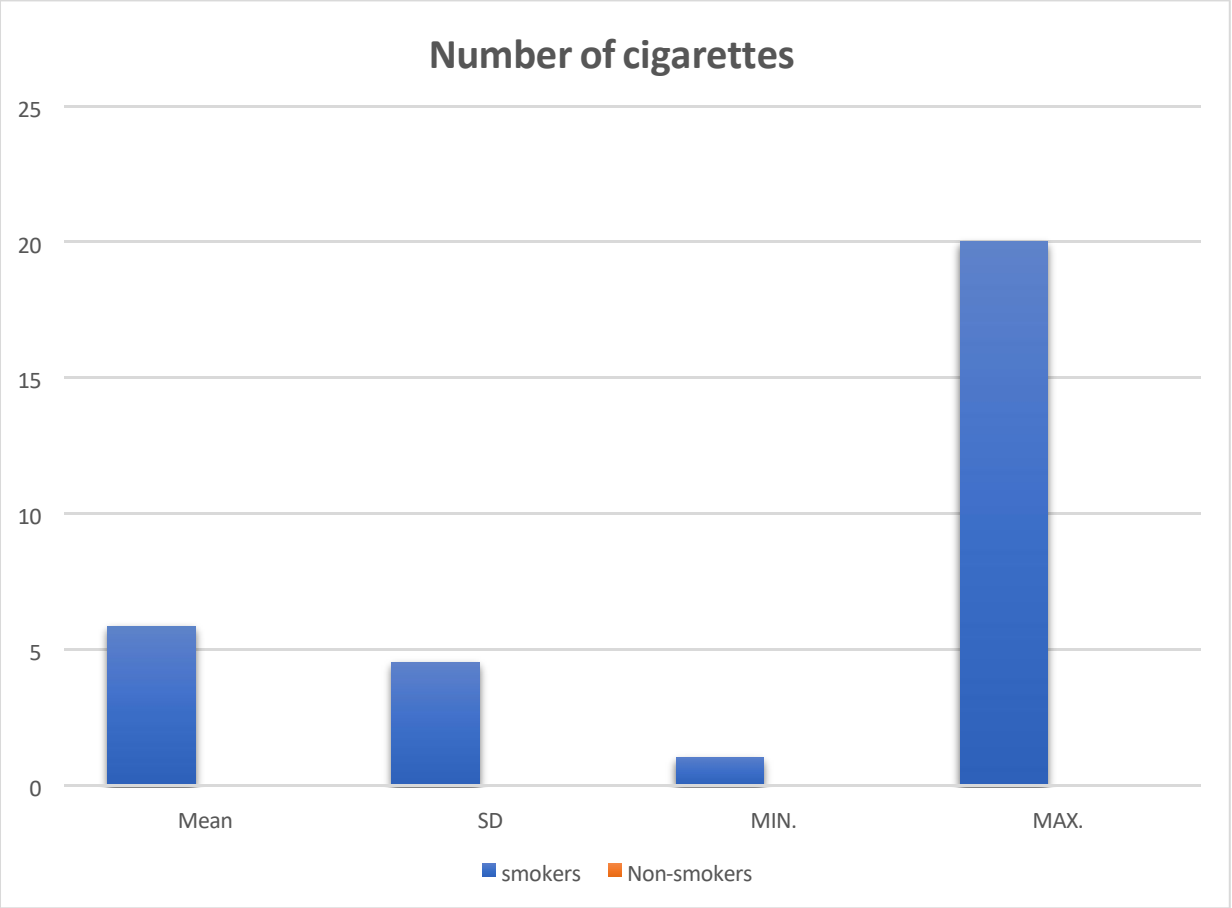

Count of Habits
62
58
Non - smoker
Smoker

❖ **Age**

Habits	Mean	SD	MIN.	MAX.
smokers	24.7586	3.11370	20.00	40.00
Non-smokers	23.2903	2.47868	20.00	30.00

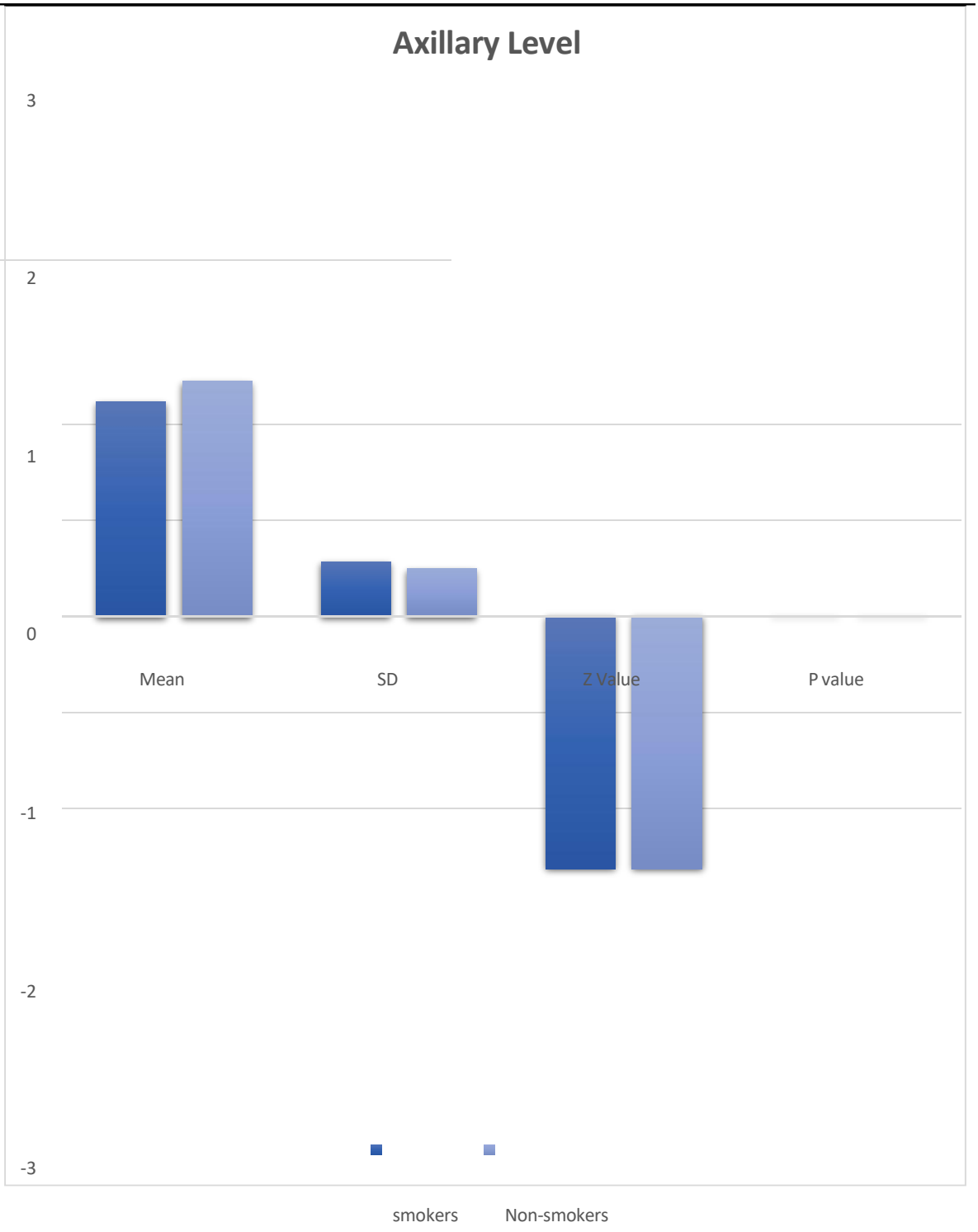
❖ **Numbers of cigarettes**

Habits	Mean	SD	MIN.	MAX.
smokers	5.8448	4.4987	1.00	20.00
Non- smokers	<0.001	<0.001	<0.001	<0.001



Axillary Level

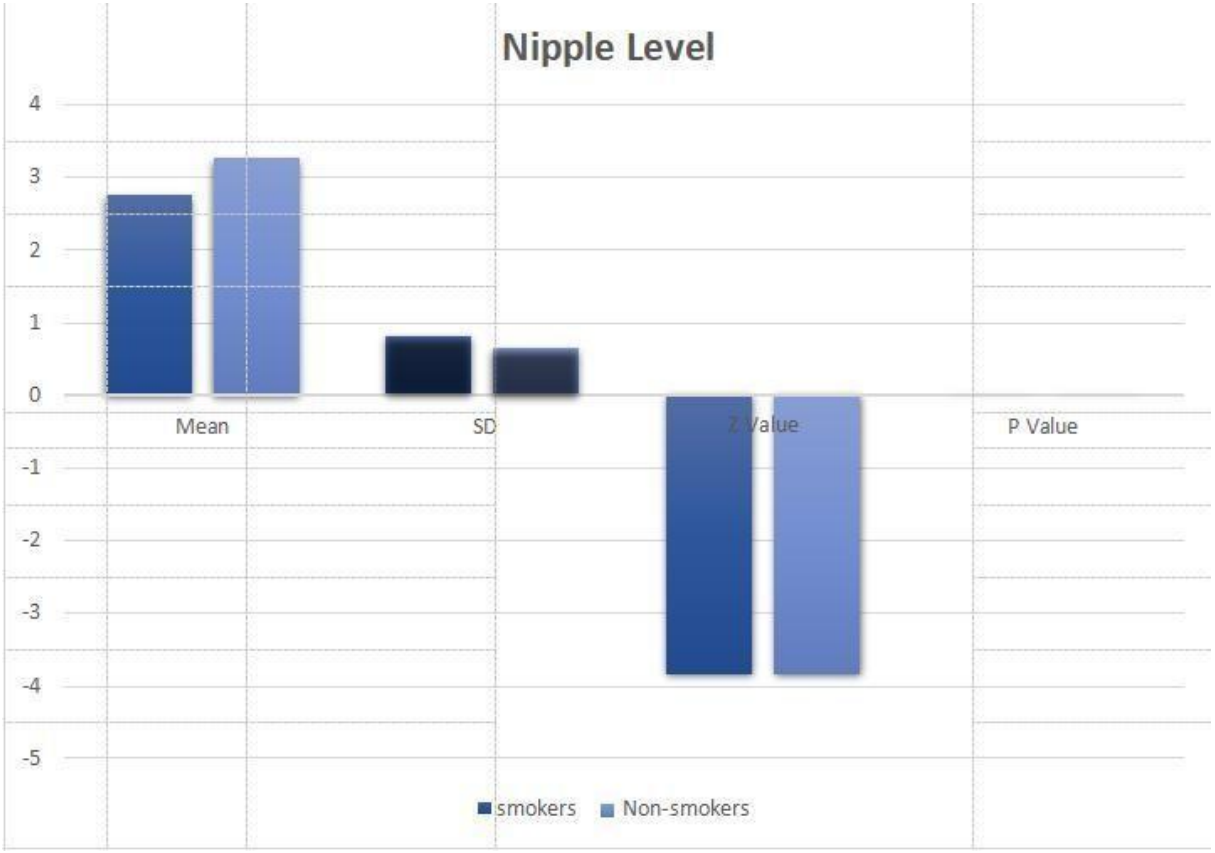
Habits	Mean	SD	Z Value	P value
smokers	2.2414	0.57156	-2.632	0.008
Non-smokers	2.4516	0.50172	-2.632	0.008



- **The P value was <u>0.008</u> so, it was statistically not significant.**

❖ **Nipple Level**

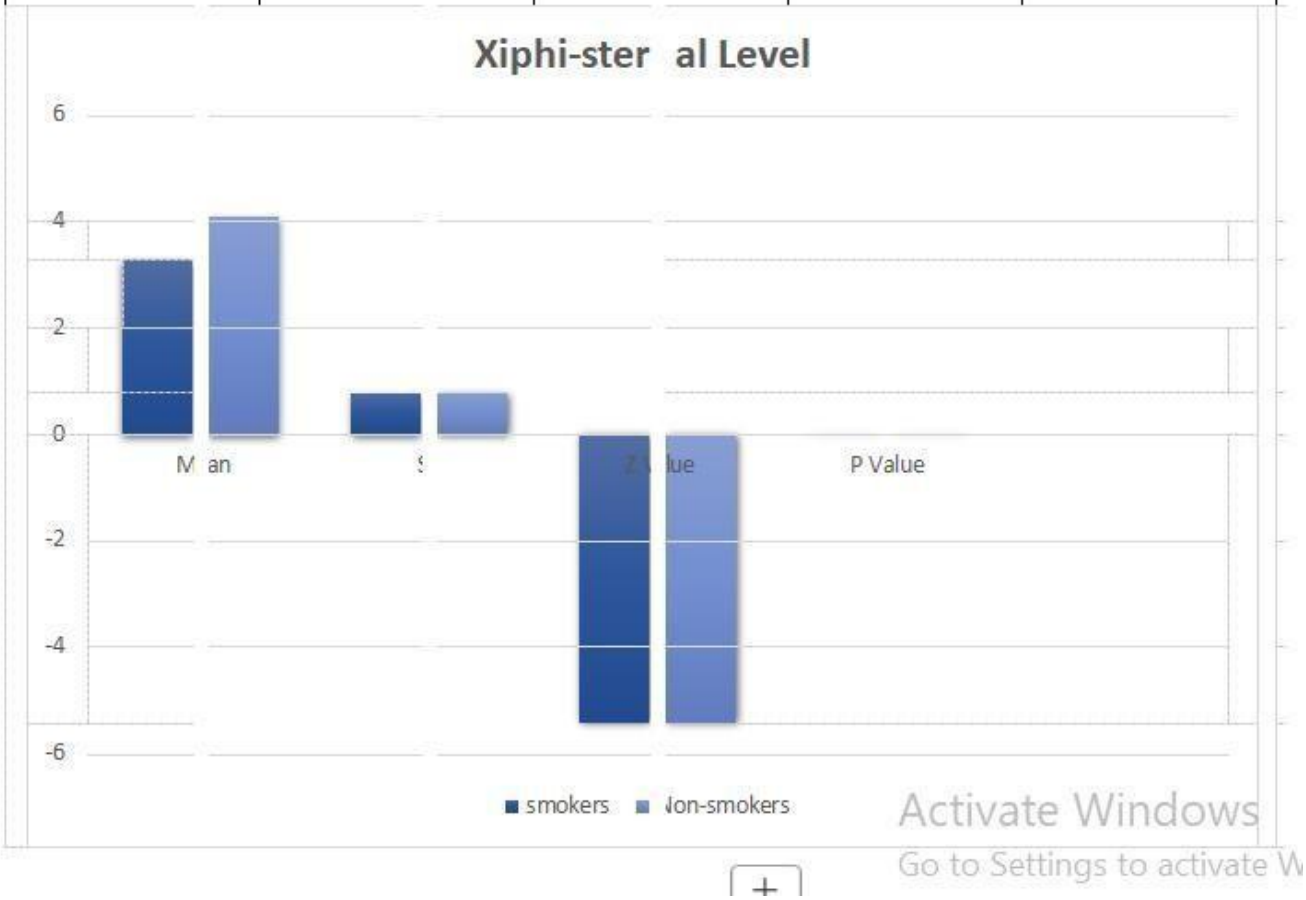
Habits	Mean	SD	Z Value	P value
smokers	2.7586	0.80154	-3.848	0.000
Non-smokers	302581	0.65124	-3.848	0.000



➢ **The P value was 0.000 so, it was statistically significant.**

Xiphi-sternal Level

Habits	Mean	SD	Z Value	P Value
smokers	3.2931	0.7725 !	-5.427	0.000
Non-smok s	4.0968	0.7832 !	-5.427	0.000



➢ **The P value was 0.000 so, it was statistically nosignificant.**

Discussion

The present study demonstrated significantly lower chest expansion values in smokers compared with non-smokers. These findings align with previous research indicating that smoking adversely affects thoracic mobility and respiratory mechanics **[1,4,10]**. Reduced chest expansion may result from airway obstruction, increased lung stiffness, respiratory muscle weakness, and altered breathing patterns induced by smoking **[5,10]**.

The greatest reduction observed at the lower thoracic (xiphisternal) level suggests impaired diaphragmatic contribution to ventilation among smokers. This may increase the work of breathing and predispose individuals to early respiratory symptoms **[1]**. Even light-to-moderate smoking was associated with measurable functional limitations, highlighting the importance of early preventive interventions **[5]**.

From a physiotherapy perspective, chest expansion measurement provides valuable clinical insight and can serve as a screening tool for early respiratory dysfunction in smokers **[3,8,11]**.

Conclusion

Smokers exhibit significantly reduced chest expansion compared with non-smokers, indicating compromised thoracic mobility and respiratory function. Early identification of these changes emphasizes the need for smoking cessation strategies and targeted physiotherapy interventions to preserve respiratory health.

Limitations

- Convenience sampling limits generalizability
- Single-center study
- Lack of spirometric correlation

Future Recommendations

- Studies with larger, multicentric samples
- Correlation of chest expansion with pulmonary function tests
- Interventional studies assessing physiotherapy outcomes in smokers

Ethical Considerations

Ethical approval was obtained from the institutional ethics committee of Parul University. Written informed consent was obtained from all participants prior to data collection.

Funding

None.

Conflict of Interest

The authors declare no conflict of interest.

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