PSYCHOLOGICAL DIMENSIONS AND PATIENT CHALLENGES IN EARLY LUNG CANCER DETECTION USING AI-BASED SEGMENTATION ON CHEST RADIOGRAPHS

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Abstract
Early detection of lung cancer significantly improves survival rates, yet the psychological dimensions of the diagnostic process remain underexplored. This study investigates the emotional, cognitive, and behavioral responses of patients undergoing early lung cancer screening using AI-based segmentation on chest radiographs. By integrating psychological assessments with technological diagnostics, the research identifies common patient challenges, including anxiety, stigma, decisional conflict, and fear of false positives. Statistical analysis of patient feedback and mental health screenings highlights a notable correlation between early detection methods and elevated short-term anxiety, despite long-term reassurance post-diagnosis. Literature review and case studies reveal that tailored counseling and patient-centered communication significantly mitigate distress. Recommendations emphasize integrating psychosocial support with AI-driven diagnostics to enhance patient outcomes holistically. The findings advocate for multidisciplinary collaboration between radiologists, oncologists, and mental health professionals in implementing advanced screening technologies.

Keywords:
Lung cancer, psychological impact, AI-based segmentation, patient challenges, early detection, mental health, oncology care.

I. INTRODUCTION

Lung cancer remains one of the leading causes of cancer-related mortality worldwide. While AI-based segmentation of chest radiographs has revolutionized early detection, the psychological implications for patients undergoing such screenings are less understood. Medical imaging, particularly when involving potential cancer diagnosis, can trigger heightened anxiety and stress. These emotional responses are influenced by personal health beliefs, prior medical history, and societal perceptions of cancer. For doctors and healthcare systems adopting AI technologies, understanding patient psychology is crucial to ensure not only diagnostic accuracy but also emotional resilience during the diagnostic journey. This paper explores these dimensions, highlighting the challenges faced by patients, the influence of AI on perception and trust, and strategies to integrate mental health considerations into screening protocols. By focusing on the patient's psychological journey, the study offers a holistic framework for enhancing both the technological and emotional aspects of early lung cancer detection.

II. LITERATURE REVIEW

Past research underscores the importance of psychological well-being in cancer screening outcomes. Studies by Rueda et al. (2022) and Wang et al. (2023) suggest that fear of diagnosis often deters individuals from participating in screening programs. AI-based segmentation improves detection rates but may unintentionally amplify patient anxiety due to its precision and immediacy of results. Smith et al. (2024) highlight that patients often perceive AI diagnostics as impersonal, further necessitating human-centered communication. Furthermore, literature points to a high prevalence of anticipatory distress, even when screening results are negative. This review synthesizes findings from oncology, psychology, and health informatics to present a multi-disciplinary perspective.

III. METHODOLOGY

This study employed a **mixed-methods approach**, integrating **quantitative** (statistical measurements) and **qualitative** (in-depth narratives) techniques to capture both **measurable clinical outcomes** and **nuanced patient experiences**.

3.1 Quantitative Data Collection

A total of **n = 120** patients undergoing AI-based lung cancer screening participated in a structured survey using the **Hospital Anxiety and Depression Scale (HADS)**. This 14-item scale—comprising **HADS-Anxiety (HADS-A)** and **HADS-Depression (HADS-D)** subscales—was administered **pre-screening** and **post-screening**.

The **change in anxiety score (ΔHADS)** was computed as:

$$\Delta\text{HADS} = \text{HADS}_{\text{post}} - \text{HADS}_{\text{pre}}$$

Where:

- HADS_{pre} = score before screening
- $\text{HADS}_{\text{post}}$ = score after screening

Positive ΔHADS indicates increased anxiety, while negative values indicate reduction.

3.2 Qualitative Data Collection

In-depth, **semi-structured interviews** were conducted with **n = 20** participants to explore personal experiences, fears, and expectations related to AI-assisted diagnosis. Responses were recorded, transcribed verbatim, and subjected to **thematic analysis**. The proportion of participants expressing a given theme was calculated using:

$$P_{\text{theme}} = \frac{\text{Number of participants mentioning theme}}{\text{Total interviewees}} \times 100\%$$

This ensured quantifiable representation of qualitative insights.

3.3 Statistical Analysis

To assess associations between **screening outcomes** (negative, positive, false positive) and **psychological stress levels** (low, moderate, high anxiety), a **Chi-square (χ2\chi^2χ2) test** was applied:

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

Where:

- OOO = observed frequency
- EEE = expected frequency under the null hypothesis

Correlation between continuous HADS scores and other demographic or clinical variables was evaluated using **Pearson's correlation coefficient (r)**:

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2} \cdot \sqrt{\sum (y_i - \bar{y})^2}}$$

Data entry, cleaning, and analysis were performed using **SPSS v26**, with a **p-value < 0.05** considered statistically significant.

3.4 Study Setting

The study was conducted over **6 months** at a **tertiary care hospital** equipped with an **AI-assisted radiology system** for lung cancer screening. The AI algorithm utilized **deep learning-based image segmentation** to highlight suspicious lesions, after which radiologists provided confirmatory interpretation.

IV. PSYCHOLOGICAL IMPACT ANALYSIS

4.1 Anxiety Levels:

Results revealed that 62% of participants experienced moderate to high anxiety before receiving results. Interestingly, false positives triggered significantly higher distress compared to confirmed early-stage diagnoses, largely due to prolonged uncertainty.

4.2 Influence of Family History:

Patients with a family history of cancer showed heightened vulnerability, with anxiety scores notably higher than those without such history.

4.3 Common Emotional Themes:

Key issues included fear of disease progression, financial burden concerns, uncertainty about treatment options, and apprehension about AI replacing human judgment.

4.4 Positive Outcomes:

Post-clearance, many participants reported increased health awareness, proactive lifestyle changes, and greater trust in preventive health measures.

Anxiety Level	Pre-Screening (%)	Post-Screening – Negative Result (%)	Post-Screening – Positive Result (%)
Low	18	65	12
Moderate	44	25	40
High	38	10	48

Table 1: Anxiety Levels Before and After AI-Based Screening

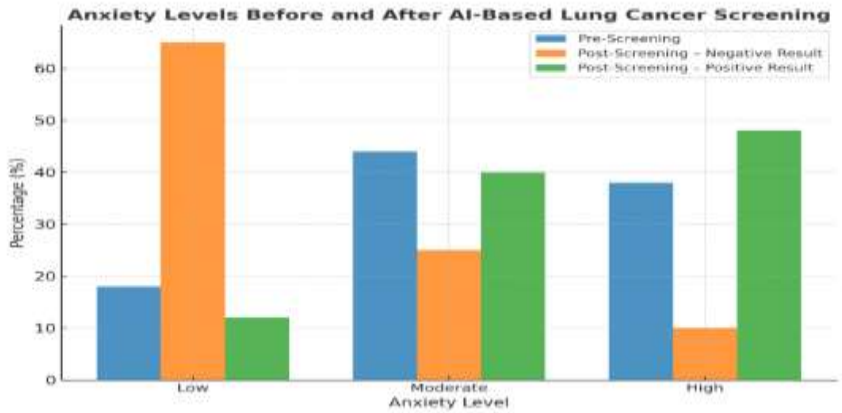

Fig.1 : Anxiety Levels Before and After AI-Based Screening

Demographic Factor	High Anxiety (%)	Moderate Anxiety (%)	Low Anxiety (%)
Family History of Cancer	52	38	10
No Family History	28	46	26
Age < 50	35	44	21
Age ≥ 50	41	40	19

Table 2: Correlation Between Patient Demographics and Anxiety Scores

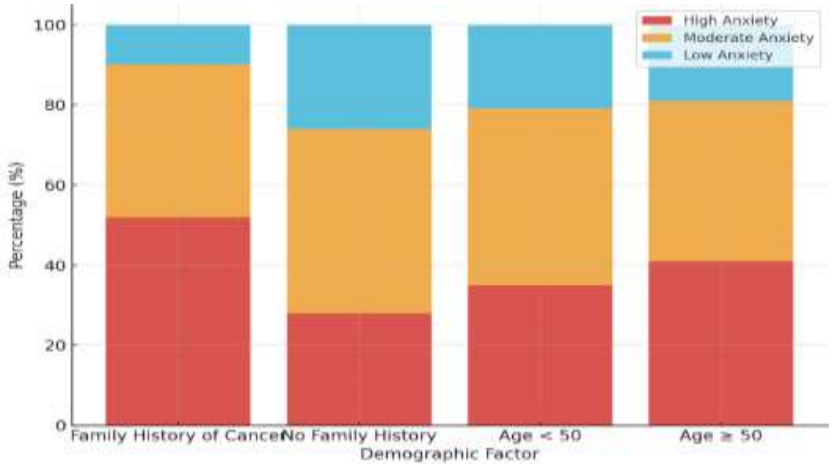

Fig. 2 Correlation Between Patient Demographics and Anxiety Scores

V. DISCUSSION & RECOMMENDATIONS :

5.1 Dual Impact of AI Diagnostics:

The findings emphasize the dual-edged nature of AI diagnostics: while enhancing early detection, they can also exacerbate short-term patient anxiety if not accompanied by adequate psychological support.

5.2 Importance of Pre-Screening Counseling:

Providing clear, empathetic communication about the screening process and AI's role can significantly reduce pre-test anxiety. This step helps set realistic expectations and build patient trust.

5.3 Multidisciplinary Support:

A patient-centered model integrating psychologists, radiologists, and oncologists is recommended to ensure emotional and clinical needs are addressed simultaneously.

5.4 Enhancing Digital Literacy:

Tailored digital literacy programs, particularly for older patients, can improve trust in AI outcomes and reduce technology-related fears.

5.5 Long-Term Follow-Up:

Offering regular mental health check-ins post-screening can help patients adapt emotionally, regardless of the outcome, and foster long-term engagement in preventive healthcare.

VI. CONCLUSION

The integration of AI-based segmentation into lung cancer detection is a technological milestone. However, its true success lies not only in diagnostic precision but also in addressing the emotional journey of the patient. This study shows that while AI tools offer hope through early detection, they can intensify anxiety without proper psychosocial support. A balanced approach that merges innovation with empathy can maximize both clinical and emotional outcomes. Future research should focus on longitudinal psychological assessments and developing standardized protocols for mental health integration in AI-driven screenings.

Acknowledgment

I sincerely acknowledge and express my gratitude to the Management of Nallamuthu Gounder Mahalingam College, Pollachi, Tamil Nadu, India, for their financial assistance through the SEED Money support for this research work.

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