# Investigating MRI-Induced Anxiety: A Study of State and Trait Anxiety Levels Using the State-Trait Anxiety Inventory

**Abinash Jha[1], Rajesh Prasad Yadav[2], Avinash Chandra[3], Shree Narayan Yadav[3]**

[1]*Department of Radiology and Imaging, National Academy of Medical Sciences, Bir Hospital, Kathmandu, Nepal*

[2]*Department of Radiology and Imaging, National Academy of Medical Sciences, Bir Hospital, Kathmandu, Nepal*

[3]*Department of Neurology, National Academy of Medical Sciences, Bir Hospital, Kathmandu, Nepal*

## CORRESPONDENCE

Abinash Jha
Department of Radiology & Imaging
National Academy of Medical Sciences,
Bir Hospital, Kathmandu,Nepal
Email: jhaabinash90@gmail.com
ORCID: 0009-0001-0392-4845

**ARTICLE INFO**
Article History
Submitted: 10 March, 2025
Accepted: 10 July, 2025
Published: 8 August, 2025

Source of support: None
Conflict of Interest: None



## ABSTRACT

**Introduction:** Magnetic Resonance Imaging (MRI) is a non-invasive imaging modality widely used in diagnostics, yet it can provoke significant anxiety that may compromise image quality and diagnostic accuracy.This study assessed MRI-induced anxiety and identified predictors of post-procedural anxiety using the State-Trait Anxiety Inventory (STAI).

**Methods:** An observational study was conducted among 384 adult patients undergoing MRI at a tertiary care hospital. The STAI-Trait (STAI-T) was administered before the scan; the STAI-State (STAI-S) was completed before and immediately after MRI. Wilcoxon signed-rank tests, independent t-tests, and multiple linear regression analyses were used.

**Results:**The mean trait anxiety score was 41.8 (SD+-8.7), with females scoring significantly higher than males ($p = 0.0004$). Although median STAI-S scores showed no statistically significant change ($p = 0.5676$), the proportion of patients with high anxiety (STAI-S ≥ 55) increased from 9.9% to 27.1% post-MRI. Female gender ($\beta = 0.21$, $p < 0.01$), first-time MRI experience ($\beta = 0.18$, $p < 0.05$), and elevated trait anxiety ($\beta = 0.38$, $p < 0.001$) were significant predictors, accounting for 38% of the variance in post-MRI anxiety (Adjusted $R^2 = 0.38$).

**Conclusion:** A substantial rise in high post-scan anxiety was observed, despite unchanged group-level averages. Routine psychological screening and targeted interventions are recommended for at-risk individuals.

**Keywords:MRI Anxiety; Procedural Distress; State-Trait Anxiety Inventory; Anxiety Predictors.**

## INTRODUCTION

Magnetic Resonance Imaging (MRI) is a cornerstone of modern diagnostics, offering high-resolution imaging of internal body structures. Despite its clinical benefits, many patients experience significant anxiety before or during MRI procedures, which can compromise image quality, prolong scan times, and affect diagnostic outcomes.[1] Contributing factors include the confined space of the scanner, loud acoustic noise, immobility requirements, and concerns about diagnostic results.[2]Additionally, anxiety is shaped by personal factors such as cultural background, previous healthcare experiences, and psychological predispositions.[3] MRI-related anxiety manifests in various forms—anticipatory (pre-scan), procedural (during scan), and post-scan anxiety about results.[4] First-time patients are particularly vulnerable due to unfamiliarity, while repeat patients may develop anticipatory stress based on past discomfort.[5] Studies have shown that anxiety varies widely across patients, depending on procedural exposure and coping mechanisms.[6] Several non-pharmacological interventions have been explored, including music therapy, pre-scan education, and environmental modifications.[6–9]

Tools such as the MRI-Anxiety Questionnaire (MRI-AQ) have helped quantify patient distress and support individualized care planning.[1] However, the effectiveness of these strategies is often inconsistent across settings and populations.

Despite the prevalence of MRI-induced anxiety, standardized approaches to assessment and management remain limited. Demographic and clinical predictors—such as gender, age, and prior MRI experience—show mixed associations with anxiety levels.[10,11]This study addresses these gaps by evaluating state and trait anxiety among MRI patients using the State-Trait Anxiety Inventory (STAI). It aims to identify key predictors of anxiety and assess changes in anxiety before and after the scan, providing insights for targeted, evidence-based interventions that enhance patient experience and diagnostic efficacy.

## METHODS

A repeated-measures observational study was conducted from November 2024 to January 2025 in the Department of Radiology and Imaging, Bir Hospital, National Academy of Medical Sciences (NAMS), Kathmandu. MRI scans were performed using a Philips Achieva 1.5 Tesla scanner. A total of 384 adult patients undergoing MRI were recruited. Sample size was calculated using $n = Z^2pq/d^2$ with an assumed anxiety prevalence of 39%, yielding a minimum required sample of 377. To enhance reliability, the study included 384 participants. Inclusion criteria were adults (≥18 years) undergoing MRI (brain, spine, abdomen/pelvis/others), able to provide consent and complete questionnaires. And patient with psychiatric illness, use of psychiatric medication, sedation, or incomplete response were excluded in the study

STAI-Trait (STAI-T) and STAI-State (STAI-S): Used to assess baseline and situational anxiety, respectively. Each scale contains 20 items rated on a 4-point Likert scale (score range: 20–80) which included demographic and clinical form including recorded age, sex, education, occupation, MRI history, referring department, and region scanned and behavioral Checklist including documented signs of nervousness, motion, or refusal. Ethical approval was obtained from IRB, NAMS (Ref: 1362/081/82). All participants gave written informed consent. Data were anonymized and securely stored. After consent, participants completed the demographic form, STAI-T, and pre-MRI STAI-S. Post-MRI, the STAI-S was re-administered, and behavioral observations were noted by staff.

Data were analyzed using SPSS v25. Descriptive statistics summarized demographic and anxiety scores. Wilcoxon signed-rank test compared pre- and post-MRI STAI-S. Independent t-tests assessed gender and MRI experience differences.Correlation and multiple regression identified anxiety predictors.

## RESULTS

A total of 384 patients participated in the study. The mean age was 45.7 years (SD = 14.6). The sample included 225 females (58.6%) and 159 males (41.4%). Most participants (62.5%) were undergoing MRI for the first time. Common MRI regions included the spine (48%), brain (34%), and abdomen/pelvis/others (18%).

**Table 1 : Characteristics of Participants**

| Variables | Category | Frequency (%) | Mean+-SD |
|---|---|---|---|
| **Age** | | | |
| Gender | Male | 159 (41.4%) | 79.17 |
| | Female | 225 (58.6%) | 20.82 |
| **MRI Experience** | First Time | 240 (62.5%) | |
| | Repeat | 144 (37.5%) | 57.14 |
| **MRI Scan** | Spine | 184 (48.0%) | 18.4 |
| | Brain | 131 (34.0%) | 7.74 |
| | Abdomen/ Pelvis/ Others | 69 (18.0%) | 16.7 |
| **Trait Anxiety Score (STAI-T)** | Overall | | 41.8 ±8.7 |
| | Male | | 39.7 ± 8.5 |
| | Female | | 43.1 ± 8.8 |

The mean trait anxiety score was 41.8 (SD = 8.7). Female participants reported significantly higher scores (mean = 43.1) than males (mean = 39.7). The difference was statistically significant (t = 3.55, p = 0.0004), indicating that female patients had greater predisposition to anxiety.

The median state anxiety score prior to MRI was approximately 40, increasing to approximately 45 post-MRI. A Wilcoxon signed-rank test indicated no statistically significant difference between pre- and post-MRI anxiety scores (W = 35,716.0, p = 0.5676). Despite this, the proportion of patients with high anxiety (STAI-S ≥ 55) increased markedly from 9.9% pre-MRI to 27.1% post-MRI, indicating a clinically meaningful increase in anxiety among a subset of patients.

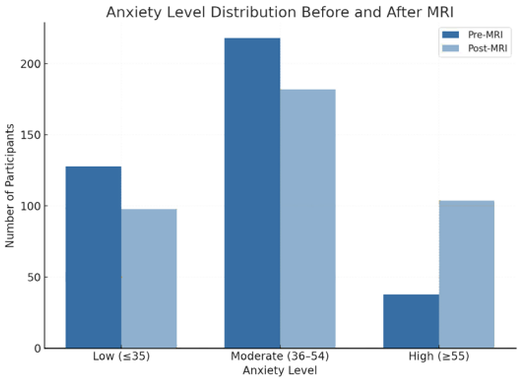


**Figure 1: Level of Anxiety before & after MRI**

Figure 1 shows a shift in anxiety levels (low: ≤35, moderate: 36–54, high: ≥55) based on STAI-S scores before and after MRI. While median anxiety scores remained statistically unchanged (W = 35,716.0, p = 0.5676), the percentage of patients with high anxiety increased from 9.9% to 27.1%, indicating a notable rise in post-procedural psychological distress.

Figure 2 compares STAI-T scores by gender and shows that females exhibited significantly higher trait anxiety levels than males (mean = 43.1 vs. 39.7; t = 3.55, p = 0.0004). This finding suggests that gender may influence an individual's predisposition to anxiety, reinforcing the importance of gender-sensitive approaches in pre-MRI psychological screening and intervention.

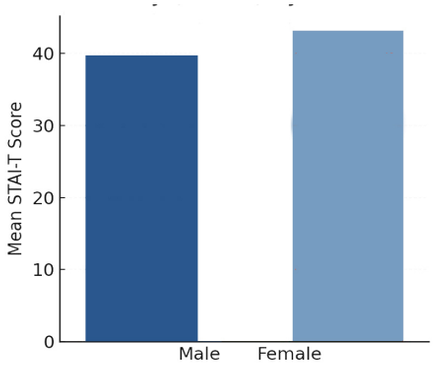


**Figure 2: Trait Anxiety by Gender**

Figure 3 represents the mean STAI-S scores before and after MRI, showing a slight increase from 36.2 (SD = 9.2) pre-MRI to 37.4 (SD = 11.3) post-MRI. Although this numerical rise is visible, the difference was not statistically significant as determined by the Wilcoxon signed-rank test (W = 35,716.0, p = 0.5676).

Similarly, Figure 4 shows that multiple linear regression analysis identified three significant predictors of elevated post-MRI state anxiety. These included high trait anxiety (β = 0.38, p < 0.001), female gender (β = 0.21, p < 0.01),

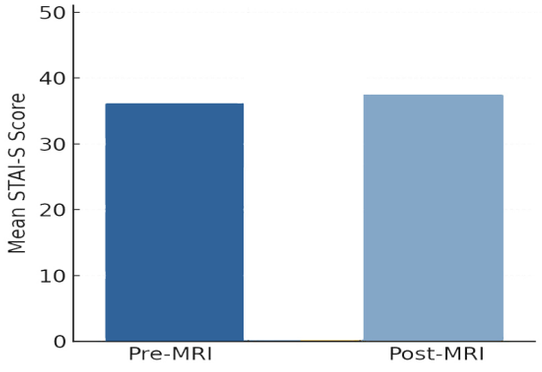


**Figure 3 : Mean state of Anxiety Before and After MRI**

and first-time MRI experience (β = 0.18, p < 0.05). Together, these factors accounted for 38% of the variance in post-scan anxiety (Adjusted $R^2$ = 0.38), supporting the utility of targeted pre-scan assessments to identify at-risk individuals Additionally, an independent samples t-test demonstrated a statistically significant difference in post-MRI anxiety scores between first-time and repeat patients: t(382) = 3.24, p = 0.001. First-time MRI attendees reported higher mean anxiety (M = 48.6, SD = 7.5) compared to those with prior MRI experience (M = 47.2, SD = 7.0), suggesting that procedural familiarity may reduce anxiety during imaging. The adjusted multiple regression model explained 38% of the variance in post-MRI state anxiety (Adjusted $R^2$ = 0.38). Among the predictors assessed, high trait anxiety, female gender, and first-time MRI experience remained statistically significant in the adjusted model. In contrast, age, educational level, and MRI region were not significantly associated with post-MRI anxiety in either the crude or adjusted analyses.

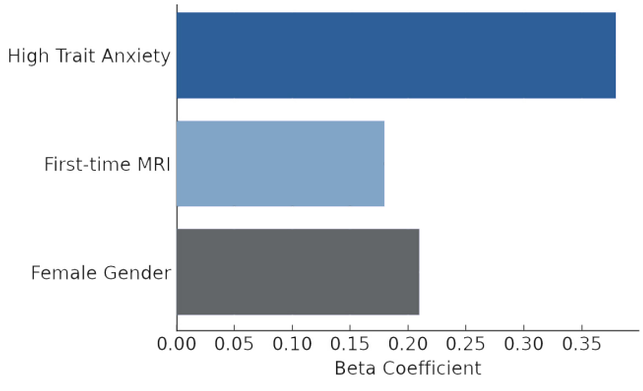


**Figure 4: Predictors of High Post-MRI Anxiety**

## DISCUSSION

This study investigated anxiety related to MRI procedures using the State-Trait Anxiety Inventory (STAI). Although the overall mean state anxiety scores before and after MRI

did not differ significantly (p = 0.5676), a notable clinical pattern emerged: the proportion of patients experiencing high anxiety (STAI-S ≥ 55) increased significantly from 9.9% to 27.1% following the scan. This indicates that while group averages may obscure statistical significance, a meaningful proportion of patients experience elevated distress during or after MRI, warranting clinical attention.

Moreover, multiple regression analysis identified female gender, first-time MRI experience, and higher trait anxiety as significant predictors of post-MRI anxiety. These variables explained 38% of the variance in anxiety scores, underscoring their clinical relevance in identifying at-risk populations. The observed rise in high anxiety levels, despite nonsignificant group-level changes, aligns with findings by Ahlander et al., who emphasized that first-time MRI patients experience greater psychological stress due to unfamiliarity with the procedure[1]. Similarly, Chapman et al. reported that environmental and situational cues—such as scanner noise or claustrophobia—can amplify anxiety, especially in sensitive individuals.[4] Gender differences in anxiety were also consistent with existing research. Females tend to report greater emotional reactivity to medical environments, a pattern that has been documented in several radiology-related anxiety studies.[3],[8] Furthermore, the role of trait anxiety—a stable personality trait indicating vulnerability to stress—was well supported by Klaming et al., who showed that individuals with high trait anxiety interpret ambiguous or confined environments more negatively, thereby exacerbating state anxiety.[7]

These findings have direct implications for clinical practice. Anxiety during MRI can contribute to motion artifacts, scan interruption, and reduced diagnostic quality, leading to potential repeat imaging and resource strain.[9] Thus, implementing targeted pre-MRI screening protocols to identify individuals at risk (especially first-timers, females, and those with high trait anxiety) is critical.Several nonpharmacological interventions have demonstrated promise in reducing procedural distress. Music therapy has been associated with improved relaxation and decreased anxiety during MRI.[6] Similarly, environmental modifications—such as dimmed lighting, noise cancellation, and patient-controlled comfort features—have led to better patient experiences.[9] Pre-scan education, including virtual walkthroughs or counselor-led briefings, can reduce anticipatory anxiety, particularly in new patients.[11]These approaches are low-cost, easy to implement, and compatible with most imaging environments. A key strength of this study is its use of a validated psychometric instrument (STAI) in a moderately large sample (n = 384). The prospective design and pre–post assessment format allow for accurate tracking of anxiety fluctuations. However, the study has limitations. First, the single-center setting may limit generalizability across different healthcare environments. Second, the design was cross-sectional, limiting causal inference. Third, the reliance on self-report questionnaires introduces the potential for reporting or social desirability bias. Finally, confounding variables—such as previous traumatic medical experiences, cultural beliefs about imaging, or undiagnosed psychiatric conditions—were not controlled.

Future research should adopt multicenter longitudinal designs to verify these findings across diverse populations. Additionally, randomized controlled trials comparing specific intervention strategies—such as guided relaxation, video-based orientation, or virtual reality acclimatization—would help develop standardized, evidence-based protocols for anxiety management during MRI. Physiological markers (e.g., heart rate variability, respiration changes) may also be incorporated alongside psychometric tools to provide objective validation of patient distress[16].

## CONCLUSION

This study demonstrates that while average state anxiety scores before and after MRI did not significantly differ, the proportion of patients with high anxiety increased substantially following the scan. Female gender, high trait anxiety, and undergoing MRI for the first time emerged as independent predictors of elevated post-procedural anxiety. These findings underscore the clinical importance of implementing pre-scan anxiety screening and delivering targeted psychological support to high-risk patients Incorporating nonpharmacological interventions such as structured education, environmental modifications, and relaxation techniques may enhance patient compliance and improve image quality. Further multicenter, longitudinal research incorporating objective physiological measures is warranted to guide the development of standardized, evidence-based protocols for anxiety management in MRI practice.

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