

Optimization of Radiation Exposure Parameters for CT Chest in Obese Patients

Farah Khan¹, Dr Ashish Kumar Shukla², Abhishek Kaushik³, Arif Hussain Malla⁴
^{1,2,3,4}*Santosh deemed to be university*

Abstract—Background: Computed Tomography (CT) is one of the most widely used diagnostic tools in modern radiology; however, its use of ionizing radiation presents significant safety concerns, especially in obese patients who require higher exposure levels to achieve diagnostic image quality. This study aims to optimize radiation exposure parameters for CT chest examinations in obese patients by modifying technical settings while adhering to the ALARA (As Low As Reasonably Achievable) principle.

Methods: A cross-sectional study was conducted on 341 obese adults aged 18–70 years undergoing CT chest scans. Data were collected for patient demographics, BMI, CT parameters (kVp, mAs, slice thickness), and dose indices (CTDIvol and DLP). Statistical analysis was used to identify correlations between patient body habitus and radiation dose, while maintaining diagnostic image quality.

Results: The average BMI was 25.9 kg/m². Dose indices (CTDIvol and DLP) showed direct proportionality with BMI and body weight. Iterative Reconstruction (IR) combined with Automatic Exposure Control (AEC) reduced the mean effective dose by 28–30% without loss of image clarity. Optimization of tube current (200–250 mA) and voltage (100–120 kVp) maintained image contrast while reducing noise. CTDIvol correlated strongly with BMI ($r=0.62$). Results confirmed that weight-specific protocols can reduce exposure substantially.

Conclusion: The study demonstrates that radiation dose can be safely reduced in obese patients through size-based protocols, AEC, and iterative reconstruction algorithms. Tailored CT chest scanning protocols maintain diagnostic efficacy while minimizing radiation exposure.

Index Terms—CT chest, Obesity, Radiation optimization, Automatic exposure control, Iterative reconstruction, ALARA principle.

I. INTRODUCTION

Obesity is a growing global health concern that affects medical imaging practices and patient safety. Defined as a Body Mass Index (BMI) greater than 30 kg/m², obesity causes excessive attenuation of X-rays during imaging, resulting in degraded image quality and increased radiation requirements. According to the World Health Organization (WHO), over 650 million adults were obese in 2016, and this number continues to rise. In diagnostic radiology, the need for dose optimization has become crucial due to the stochastic risks of ionizing radiation exposure.

Computed Tomography (CT) of the chest is commonly performed for detecting pulmonary diseases, infections, and malignancies. However, the radiation dose in CT is significantly higher compared to conventional radiography. Optimizing CT parameters in obese patients involves balancing radiation exposure and image quality. Excessive dose reduction may compromise diagnostic confidence, while insufficient reduction increases cancer risk.

Advances in CT technology such as multi-detector CT (MDCT), automatic exposure control (AEC), and iterative reconstruction (IR) have made it possible to lower radiation doses while maintaining diagnostic image quality. The ALARA principle emphasizes the need to minimize exposure without compromising diagnostic yield. This study aims to establish optimized scanning parameters specific to obese patients, promoting patient safety while ensuring reliable diagnostic outcomes.

II. REVIEW OF LITERATURE

Several studies have evaluated radiation dose optimization in CT imaging. Abuzaid et al. (2025) reported a direct correlation between BMI and dose-length product (DLP) in HRCT chest, suggesting that heavier patients require individualized dose settings. Manava and Galster (2023) demonstrated that 3D camera-based patient positioning significantly reduces unnecessary exposure by ensuring accurate centering. Greffier et al. (2023) highlighted the benefits of tin filters in ultra-low-dose CT imaging, reducing low-energy photon noise and patient dose.

Wen et al. (2023) introduced low-kVp coronary CT angiography with Deep Learning Image Reconstruction (DLIR), showing improved image clarity even at lower tube voltages. Dolenc et al. (2022) showed a proportional rise in effective dose with BMI, emphasizing the need for adaptive imaging protocols. Kumar et al. (2022) compared HRCT thorax protocols and found that adjusting reconstruction matrices and voltage improved diagnostic sharpness while reducing dose.

Alshamrani et al. (2021) reported that iterative reconstruction can reduce radiation by up to 60% in obese individuals while maintaining image quality. Similarly, Panayiotakis et al. (2018) stressed that BMI-based Diagnostic Reference Levels (DRLs) should guide dose selection to prevent unnecessary exposure. These findings collectively support the importance of developing patient-specific scanning strategies.

III. MATERIALS AND METHODS

Study Design: A cross-sectional study involving 341 obese patients (BMI >25 kg/m²) who underwent CT chest scans.

Data Collection: Demographic data (age, gender, height, weight, BMI), scan parameters (kVp, mAs, slice thickness), and radiation dose indices (CTDIvol, DLP) were recorded. Automatic Exposure Control (AEC) and Iterative Reconstruction (IR) algorithms were utilized.

Statistical Analysis: Statistical correlations were performed using SPSS software. Pearson correlation was used to evaluate relationships between BMI, CTDIvol, and DLP.

Inclusion Criteria: Male and female patients aged 18–70 years, BMI >25 kg/m².

Exclusion Criteria: Incomplete datasets, poor image quality, or outdated CT scanners.

Ethical Consideration: The study adhered to ethical guidelines for radiation safety, ensuring confidentiality and minimal exposure.

IV. RESULTS AND CHART SUMMARIES

A total of 341 participants were analyzed, with 52.2% males and 47.8% females. The mean BMI was 25.9 kg/m². Most patients were between 22–34 years of age. Slice thickness of 3.0 mm was used in 98.2% of scans.

- **Age Distribution:** The highest frequency was observed in the 25–27-year age group.
- **Gender Distribution:** Slight male predominance (52.2%).
- **BMI Distribution:** Majority clustered between 24.9–27.1, indicating mild obesity.
- **Dose Metrics:** Average CTDIvol was 15.8 mGy, and DLP averaged 620 mGy·cm.
- **Correlation:** BMI showed a strong positive correlation with CTDIvol ($r=0.62$, $p<0.01$).

Chart Summaries:

1. Figure 1 – Age Distribution: Peak between 25–27 years.
2. Figure 2 – Gender Distribution: Balanced with slight male dominance.
3. Figure 3 – BMI vs CTDIvol: Linear correlation between body size and dose.
4. Figure 4 – Effect of IR on Image Quality: Noise reduction of ~25%.

These results suggest that optimized protocols using 100–120 kVp and AEC modulation yield diagnostic-quality images with lower radiation dose.

V. DISCUSSION

The findings reinforce the relationship between obesity and increased radiation dose in CT chest

imaging. As body mass rises, attenuation increases, leading to higher tube current requirements. This challenge can be mitigated through technological adjustments such as AEC and iterative reconstruction. The study demonstrated a 28–30% dose reduction while maintaining diagnostic image quality.

Our results are consistent with previous research by Alshamrani et al. (2021) and Dolenc et al. (2022), who also observed improved dose efficiency using adaptive reconstruction techniques. AEC ensures that tube current is automatically adjusted according to patient size, preventing overexposure. Moreover, using iterative reconstruction reduces image noise at lower doses compared to traditional filtered back projection.

Clinical Implications: Implementing BMI-specific protocols ensures personalized radiation protection. Radiographers should monitor CTDI_{vol} and DLP for each patient and apply SSDE (Size Specific Dose Estimates) for precise dose evaluation. Future CT technologies with AI-based reconstruction and spectral shaping can further reduce exposure.

VI. CONCLUSION

Radiation exposure in CT chest imaging can be significantly optimized in obese patients through individualized scanning protocols. Automatic Exposure Control, Iterative Reconstruction, and BMI-based dose modulation are effective strategies to ensure diagnostic-quality images with minimal exposure. Establishing BMI-specific reference levels and adopting advanced reconstruction technologies will enhance patient safety and diagnostic confidence.

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