Knowledge of Digital Breast Tomosynthesis and Breast Interventions Among Radiography Students and Professionals: A Cross-Sectional Online Survey

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Background: Digital breast tomosynthesis (DBT), synthetic two-dimensional mammography, and image-guided breast interventions require radiographers and radiography trainees to understand both imaging principles and procedural workflow. Evidence describing knowledge of these topics among Indian radiography learners and professionals is limited.

Objective: To describe performance on a researcher-developed 25-item online knowledge questionnaire addressing DBT, mammography equipment, stereotactic breast biopsy, vacuum-assisted biopsy, contrast-enhanced mammography, and breast lesion localization.

Methods: A cross-sectional online survey used convenience sampling. The uploaded Google Forms export contained 71 responses collected between 4 April and 16 September 2026. Total scores were taken from the platform's recorded score field (maximum 25). Item-level correctness was calculated from the platform's per-question score fields. Because role labels were heterogeneous and the questionnaire's validity was not established, the primary analysis was descriptive.

Results: The mean recorded score was 20.62 (SD 4.63) out of 25, equivalent to 82.5%; the median was 22 (IQR 18–24), with scores ranging from 6 to 25. Sixteen respondents (22.5%) received a perfect score. Correct responses were most frequent for recognition of tissue-overlap artifact reduction in DBT (67/71, 94.4%) and use of paired angled images to minimize parallax error in stereotactic guidance (66/71, 93.0%). The lowest item-level correctness was for the question on mammography anode material (38/71, 53.5%) and confirmation of calcification retrieval by specimen radiography (46/71, 64.8%).

Conclusion: Respondents performed well on several core conceptual questions, while responses suggested potential learning needs in mammography equipment physics and specimen radiography. These results are exploratory and should not be interpreted as a nationally representative estimate or as evidence of clinical competence. Ethics status, informed-consent documentation, and the questionnaire answer key require resolution before publication.

Keywords: digital breast tomosynthesis; mammography; radiography; radiologic technologists; breast biopsy; stereotactic biopsy; contrast-enhanced mammography; knowledge assessment; India.

I. INTRODUCTION Mammography remains an important modality for breast cancer detection, while digital breast tomosynthesis (DBT) adds limited-angle projection acquisition and reconstruction to reduce the masking effects of overlapping tissue. By presenting the breast in reconstructed sections, DBT can improve assessment of focal asymmetries, masses, and architectural distortion; however, image quality and interpretation remain affected by acquisition geometry, reconstruction, motion, and system-specific parameters [1–4].

Synthetic mammography images are reconstructed from DBT data and may reduce the need for a separate conventional two-dimensional acquisition in selected protocols. Their use is not simply a universal replacement rule: image appearance, calcification assessment, artifacts, dose, and local protocols should be considered in the context of the equipment and clinical indication [3,4].

Breast imaging practice also involves image-guided procedures, including stereotactic or DBT-guided localization and biopsy. Stereotactic targeting relies on paired projections and parallax to estimate lesion depth, while vacuum-assisted biopsy can obtain multiple tissue samples through a single insertion and is commonly used for mammographically detected

abnormalities, including calcifications [5]. Specimen radiography is important when the target consists of mammographic calcifications because it helps confirm that calcifications have been retrieved in the sampled tissue [6]. Contrast-enhanced mammography uses iodinated contrast and dual-energy acquisitions to highlight enhancement associated with tumor vascularity, adding functional information to conventional mammographic imaging [7].

Radiographers and radiography students contribute to image acquisition, patient positioning, quality assurance, procedural support, radiation protection, and workflow. A sound understanding of DBT physics and breast intervention principles is therefore relevant to safe and effective practice. Nevertheless, knowledge scores from an unvalidated questionnaire reflect performance on the questions asked rather than direct observation of practical skill or clinical competence.

The present survey was designed to describe responses to a 25-item questionnaire covering DBT, mammography equipment, stereotactic guidance, vacuum-assisted biopsy, contrast-enhanced mammography, and lesion localization. Given convenience sampling and an unknown geographic distribution, the study is exploratory rather than a national prevalence survey.

Objectives

The primary objective was to describe total scores and item-level response performance on a researcher-developed online knowledge questionnaire about DBT and breast interventions.

The secondary objective was to identify questionnaire items with comparatively lower correct-response proportions that may merit review as potential topics for education and future instrument development.

Materials and Methods

Study design and setting

This was a cross-sectional online questionnaire survey. The data were exported from Google Forms as a CSV file. The recorded timestamps ranged from 4 April 2026 to 16 September 2026. The geographic reach of recruitment was not documented in the information supplied; therefore, the sample cannot be described as nationally representative.

Participants and sampling

Convenience sampling was used. The intended population included both students and working professionals associated with radiography, radiology technology, or related roles. The form contained self-reported designation and institution fields, but designation labels varied considerably in spelling, capitalization, and specificity. One designation field contained text that appeared unrelated to a job title. Because these labels were not collected using standardized categories, subgroup comparisons by professional status were not conducted for this draft.

Questionnaire

The researcher-developed questionnaire comprised 25 multiple-choice items. The topics included the principle and benefits of DBT; approximate reconstructed slice thickness; synthetic 2D images; stereotactic angulation, localization needles, parallax, and Z-axis; mammography anode and target/filter choices; vacuum-assisted biopsy; clip placement; contrast-enhanced mammography; hookwire migration; and specimen radiography. The available dataset did not establish that the questionnaire underwent formal expert content validation, cognitive interviewing, pilot testing, or reliability analysis. These details should be added only if they were actually performed.

Scoring and outcome measures

The primary outcome was the total score recorded by Google Forms, out of 25. Item-level correctness was derived from the exported per-question score fields, with one point representing a response marked correct by the form's configured key. The key was not independently re-administered or validated as part of this analysis. Therefore, the results describe performance according to the platform's scoring key and should not be interpreted as a validated measure of competence.

Data management and statistical analysis

The CSV contained 71 records and no exact duplicate rows. Total scores were summarized using mean, standard deviation, median, interquartile range, and

minimum–maximum. Item-level results were expressed as the number and percentage of respondents whose answers were marked correct. Gender entries were inconsistently formatted; descriptive counts were normalized only where the label was unambiguous. One entry ('Make') was treated as unclassifiable rather than recoded to a binary category. No inferential tests were performed because the study aim was descriptive and role labels and questionnaire validity did not support defensible subgroup analysis. Analyses were performed from the supplied CSV export.

Ethics and consent

The researcher reported that ethics approval was not sought. The available CSV did not establish whether participants received an information sheet or provided informed consent, nor did it include an ethics approval or exemption reference. This is a material unresolved issue. Before submission, the authors should obtain written guidance from the relevant institutional research ethics committee and the intended journal, and accurately document participant information, consent, data protection, and any applicable review determination. No approval or exemption is claimed in this manuscript.

Reporting guideline

The manuscript structure follows relevant elements of the STROBE guidance for cross-sectional studies [8]. The STROBE checklist is a reporting aid and does not substitute for ethical review or establish study quality.

Results

Response set and total knowledge scores

The dataset contained 71 submitted records, all with a recorded total score. The mean score was 20.62 (SD 4.63) out of 25 (82.5%); the median was 22 (IQR 18–24), and the range was 6–25. Sixteen respondents (16 of 71, 22.5%) achieved 25/25. 7 respondents (9.9%) scored below 15/25. These are descriptive statistics of platform-recorded scores and are not adjusted for respondent background or questionnaire measurement properties.

Measure	Result
Responses included	71
Knowledge questionnaire	25 multiple-choice items
Mean score (SD)	20.62 (4.63) / 25
Mean percentage	82.5%
Median (IQR)	22 (18–24)
Range	6–25
Perfect score, n (%)	16 (22.5%)
Score below 15/25, n (%)	7 (9.9%)

Item-level performance

The highest proportion of correct responses was recorded for the item on reduced tissue-overlap artifact in DBT (94.4%). The items on using dual-angled images to minimize parallax error and the advantage of vacuum-assisted biopsy (single insertion for multiple samples) were each answered correctly by 93.0% of respondents. The lowest proportion was observed for the question on anode material in modern mammography tubes (53.5%), followed by specimen radiography for confirming calcification retrieval (64.8%).

Item	Topic/question (shortened)	Correct	Correct (%)
1	1.The main advantage of DBT over conventional mammography is	63/71	88.7%
2	2. Slice thickness in DBT is approximately:	52/71	73.2%
3	3.Synthetic 2D images in DBT are used to:	61/71	85.9%
4	4. DBT reduces:	57/71	80.3%
5	5.Which artifact is reduced in DBT compared to 2D mammography?	67/71	94.4%
6	6. Standard angulation used in stereotactic mammography is	56/71	78.9%
7	7.The needle used before wire insertion is:	64/71	90.1%
8	8. In stereotactic guidance, parallax error is minimized by:	66/71	93.0%
9	9. Modern mammography tubes commonly use which anode material?	38/71	53.5%
10	10. Modern mammography tubes are designed with:	53/71	74.6%
11	11. Target/filter combination for dense breasts in modern systems:	52/71	73.2%
12	12. Stereotactic biopsy uses which principle?	62/71	87.3%
13	13. Vacuum-assisted biopsy (VAB) advantage over core biopsy:	66/71	93.0%
14	14. Most commonly used needle gauge in VAB:	56/71	78.9%
15	15. Why compression is maintained during biopsy?	56/71	78.9%
16	16. Clip placement after biopsy is done to:	62/71	87.3%
17	17. In stereotactic biopsy, Z-axis refers to:	65/71	91.5%
18	18. Which biopsy has highest tissue yield?	57/71	80.3%

19	19.Synthetic 2D mammography images are generated from:	64/71	90.1%
20	20. Contrast-enhanced mammography (CEM) uses:	65/71	91.5%
21	21. Dual-energy technique in CEM helps to:	63/71	88.7%
22	22. DBT is NOT a true CT because:	56/71	78.9%
23	23.. A dense breast patient shows no lesion on 2D but DBT reveals distortion. Reason?	64/71	90.1%
24	24. Hookwire migration most commonly occurs:	53/71	74.6%
25	25. Most accurate method for confirming calcification removal:	46/71	64.8%

Respondent characteristics

The gender field contained 39 entries explicitly labelled female, 31 explicitly labelled male, and 1 entry that could not be reliably classified from the recorded label. These figures should be treated as a cleaned description of the form entries, not as a validated demographic variable. Institutions and designations were entered as free text and included spelling and formatting variations; no geographic distribution can be inferred from these fields.

Gender field after conservative normalization	n (%)
Female	39 (54.9%)
Male	31 (43.7%)
Unclassifiable entry	1 (1.4%)

Discussion

In this convenience sample of 71 respondents, the average platform-recorded score was 20.62/25, or 82.5%, and nearly one quarter achieved a perfect score. At the same time, correct-response proportions varied by item. The strongest responses concerned the core DBT concept of reducing tissue superimposition and the use of paired projections for stereotactic depth estimation. The lowest-performing items concerned mammography anode material and confirmation of calcification retrieval.

The pattern is broadly consistent with the conceptual role of DBT: limited-angle acquisitions and reconstruction reduce the masking effects of tissue overlap, although DBT is not equivalent to conventional CT and remains subject to acquisition- and reconstruction-related limitations [1–4]. The item on slice thickness should be interpreted cautiously because reconstructed slice thickness depends on vendor and software settings; a single approximate value cannot be assumed to apply to every system [2,3].

The comparatively low correctness for anode material may indicate uncertainty about modern mammography equipment, but the item itself needs review. Mammography systems differ by generation and manufacturer, and target/filter combinations are selected according to equipment design and imaging task. The question's use of 'modern' and its limited response options may simplify a more variable technical reality. This result should therefore be treated as a signal to review the teaching item, not definitive evidence of a widespread knowledge deficit.

The specimen-radiography item had the second-lowest correctness. Specimen radiography is an established method for checking whether mammographically visible calcifications have been retrieved during image-guided biopsy and can inform the adequacy of sampling [6]. The result suggests that this topic may warrant greater emphasis in teaching about the full intervention workflow, including target confirmation, specimen handling, documentation, and radiologist–technologist communication.

Responses to intervention questions were generally high, including the use of vacuum-assisted biopsy to obtain multiple samples and the role of clip placement in marking the biopsy site. However, these responses do not establish procedural competence. A multiple-choice questionnaire cannot assess positioning, sterile technique, patient communication, recognition of complications, radiation protection, image quality, or team coordination. Future work should pair knowledge assessment with practical or workplace-based evaluation.

Contrast-enhanced mammography questions were answered correctly by a high proportion of respondents. CEM uses iodinated contrast and dual-energy acquisition to highlight enhancement relative to background tissue [7]. Education should include not only the physical principle but also patient selection, contrast safety, acquisition protocols, image interpretation pathways, and local governance.

The present findings should be considered hypothesis-generating. Existing survey research on DBT has often focused on radiologists' use and perceptions rather than knowledge among mixed groups of radiography students and professionals [9,10]. The current dataset offers a different perspective by including technical and procedural concepts, but its convenience sample, unknown geographic reach, and unvalidated questionnaire prevent direct comparison with representative workforce studies.

Implications for education and practice

A focused educational module could prioritize mammography tube target/filter selection and equipment-specific protocols; specimen radiography and calcification retrieval; the limitations of fixed 'standard' values when parameters vary by vendor; and the workflow of stereotactic and DBT-guided interventions. Teaching should use equipment-specific protocols and expert-reviewed case scenarios. Any future assessment should distinguish foundational concepts from system-dependent details and should define the intended level of competence.

Strengths

The survey addresses multiple domains within breast imaging in one short instrument and includes both trainees and people reporting professional roles. The item-level output makes it possible to identify questions that respondents found relatively easy or difficult, which can guide refinement of educational materials and the questionnaire.

Limitations

Several limitations materially affect interpretation. First, convenience sampling and an undocumented geographic reach introduce selection bias and prevent national generalization. Second, the sample includes students and professionals, but free-text designation labels were heterogeneous, limiting reliable subgroup analysis. Third, the questionnaire was researcher-developed and no formal content validation, reliability testing, or pilot testing could be confirmed from the information supplied. Fourth, the platform's answer key was used for scoring and some items may be ambiguous or equipment-dependent; the score therefore should not be treated as a validated knowledge scale. Fifth, the available export did not establish whether informed consent was obtained. Sixth, ethics review was not sought, which must be resolved before journal submission. Finally, the study measured selected factual responses and did not assess practical performance, clinical behavior, or patient outcomes.

Future research

Future studies should use an expert-reviewed questionnaire with a documented blueprint, content-validity assessment, pilot testing, and appropriate reliability evaluation. Recruitment should be planned across defined regions and institutions, with standardized categories for trainee status, professional role, years of experience, and exposure to mammography or breast interventions. A prespecified sample-size rationale and analysis plan should be used. Where feasible, knowledge scores should be compared with objective structured practical assessment or supervised procedural competencies.

Conclusion

Among 71 respondents to an online convenience survey, platform-recorded knowledge scores were generally high, but performance varied across items. Questions on mammography anode material and specimen radiography for calcification retrieval had the lowest correct-response proportions. These results may help prioritize educational content and improve the questionnaire, but they cannot be generalized to Indian radiographers as a whole or interpreted as evidence of clinical competence. Before publication, the authors must resolve the ethics position, confirm consent documentation, and obtain expert review of the questionnaire and its answer key.

Declarations

Ethics approval: Ethics approval was not sought. The authors must obtain written guidance from the relevant institutional ethics committee and the target journal before submission. No approval or exemption is claimed.

Consent to participate: Not verifiable from the supplied CSV. The authors must confirm whether participant information and consent were obtained and report this accurately.

Consent for publication: Not applicable to the aggregate results presented here; confirm journal-specific requirements.

Availability of data: The de-identified analysis dataset may be made available by the corresponding author subject to institutional policy, participant consent, and applicable data-protection requirements. Confirm before submission.

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Use of generative AI: Authors should follow the target journal's policy and disclose any use of AI-assisted writing or analysis if required. All authors must review and take responsibility for the final manuscript.

Reporting guideline: STROBE guidance for cross-sectional studies was used to structure the report.

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