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Radiology Under the Spotlight: Awareness, Misconceptions, and Utilization Patterns of Diagnostic Imaging Modalities Among the General Population of Punjab

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Abstract

Background: Diagnostic imaging plays a vital role in clinical decision-making; however, public understanding of imaging modalities, radiation exposure, and appropriate use remains inconsistent. Misconceptions may affect acceptance, demand, and compliance with medical advice. This study evaluated awareness, misconceptions, and utilization patterns of diagnostic imaging among the general population of Punjab. ***Methods:*** A community-based cross-sectional study was conducted using a self-administered Google Form questionnaire over four months. Adults aged ≥18 years residing in Punjab were included, while healthcare professionals were excluded. A total of 420 responses were analysed. The tool assessed socio-demographic details, awareness (20 items), misconceptions (20 statements), and utilization patterns (20 items). Scores were categorized into defined levels. Chi-square test assessed associations, and Pearson's correlation evaluated relationships among awareness, misconception, and utilization scores ($p<0.05$ considered significant). ***Results:*** Among participants, 29.0% were aged 26–35 years, 53.3% were female, and 71.9% resided in urban areas. Awareness was highest for ultrasound use in pregnancy (83.8%) and its principle (81.9%), but lower for nuclear medicine (51.9%), PET (53.8%), and radiation dose concepts (51.0%). Overall awareness was excellent in 22.9% and good in 42.4% (mean 13.4 ± 3.2). Moderate misconceptions were observed in 45.2% (mean 12.8 ± 3.4). Imaging utilization was high, with 80.0% having undergone imaging and 71.9% following physician advice; however, only 51.0% recalled radiation risk counselling, and 52.9% reported cost influence. Education, income, occupation, and age were significantly associated with awareness, misconceptions, and utilization ($p<0.05$). Awareness positively correlated with utilization ($r=0.536$) and misconception score ($r=0.482$) ($p<0.01$). ***Conclusion:*** While awareness of common imaging modalities was satisfactory, gaps in advanced imaging knowledge and persistent misconceptions remain. Although utilization was largely physician-directed, limited recall of radiation counselling and cost concerns highlight the need for strengthened patient education and communication to promote rational and safe imaging practices.

Keywords: Diagnostic imaging, Radiology awareness, Radiation literacy, Misconceptions, Imaging utilization, Public health, Punjab, Cross-sectional study.

INTRODUCTION

Diagnostic imaging has become an essential component of modern healthcare, guiding diagnosis, treatment planning, and disease monitoring across medical specialties. Modalities such as X-ray, ultrasound, computed tomography (CT), magnetic resonance imaging (MRI), and nuclear medicine have significantly improved clinical accuracy and patient outcomes.1-3 With expanding healthcare infrastructure and increasing availability of imaging centres, access to radiological investigations has grown rapidly in India, including the state of Punjab.

Despite this technological advancement, public awareness regarding different imaging modalities, their indications, benefits, and potential risks remains variable. Many individuals are familiar with common investigations such as X-ray or ultrasound but may lack clarity about radiation exposure, safety differences between CT and MRI, or the clinical necessity of specific scans. Misconceptions—such as believing that all scans use harmful radiation or that repeated imaging inevitably causes cancer—can influence health-seeking behaviour. Such misunderstandings may lead either to unwarranted fear and refusal of medically indicated investigations or to inappropriate demand for advanced imaging without proper indication.4-7

Radiation safety has become an increasingly discussed public health issue. While medically justified imaging provides substantial benefit, rational utilization and informed patient understanding are essential to prevent overuse and reduce unnecessary exposure. Evaluating how the general population perceives diagnostic imaging is therefore important for strengthening patient–physician communication and promoting evidence-based use of radiological services.8-12
Punjab, with its improving literacy levels and expanding healthcare services, represents a suitable setting to assess community-level understanding of radiology. However, data exploring awareness, misconceptions, and utilization patterns of imaging modalities among the general population remain limited.

Therefore, the present study aims to assess the level of awareness, identify prevalent misconceptions, and analyze utilization patterns of diagnostic imaging modalities among the general population of Punjab. Understanding these factors may help guide educational initiatives and encourage rational, informed use of radiological investigations.

MATERIALS AND METHODS

Study Design and Setting

A community-based, descriptive cross-sectional study was conducted to assess awareness, misconceptions, and utilization patterns of diagnostic imaging modalities among the general population of Punjab, India. The study was carried out over a four-month period (October, 2025 –January, 26) using a digital, self-administered Google Form questionnaire. The online format was selected to facilitate wider geographic reach, rapid data collection, and inclusion of participants from diverse urban and semi-urban settings across the state.

Study Population

The target population included adults aged 18 years and above who had been residing in Punjab for at least one year. Individuals willing to participate voluntarily and capable of completing an online questionnaire independently were included in the study. Healthcare professionals—including doctors, radiologists, radiographers, nurses, and medical students—were excluded to minimize professional knowledge bias. Participants submitting incomplete forms were excluded from final analysis.

Sample Size Determination

The sample size was calculated using the single population proportion formula, assuming a 50% expected awareness level due to the absence of comparable regional community-based data, a 95% confidence interval, and a 5% margin of error. The minimum calculated sample size was 384 participants. To account for potential incomplete responses and enhance statistical precision, the final target sample size was increased to 420 respondents.

Sampling and Data Collection Approach

Data were collected using a structured Google Form survey link that was distributed through community networks, resident welfare associations, educational institutions, and social media platforms including WhatsApp, email, and Facebook. Participation was voluntary, and respondents could access the questionnaire through smartphones, tablets, or computers.
To improve representativeness, responses were monitored periodically to ensure inclusion across different age groups, genders, educational backgrounds, and socioeconomic categories. The first section of the Google Form included a brief description of the study objectives and an informed consent statement, and only those who provided consent were able to proceed to the questionnaire.
Each participant required approximately 10–15 minutes to complete the survey. Confidentiality was maintained by not collecting identifying personal information.

Data Collection Instrument

A structured, pre-tested questionnaire was developed after reviewing relevant literature on diagnostic imaging awareness and radiation safety. The instrument was designed to be simple, comprehensible to the general population, and scientifically accurate.
The questionnaire comprised four sections:

Section I: Socio-Demographic Profile

This section included age, gender, education level, occupation, monthly household income, and area of residence (urban/semi-urban).

Section II: Awareness of Diagnostic Imaging Modalities
This section assessed knowledge regarding common imaging techniques such as X-ray, ultrasound, CT, MRI, and nuclear medicine. Questions evaluated understanding of radiation exposure, safety differences between modalities, indications for use, awareness of contrast agents, and identification of radiation-free modalities. Each correct response was awarded one point, while incorrect or "don't know" responses received zero.

Section III: Misconceptions and Perceptions
Participants responded to statements addressing common myths related to imaging, including beliefs that all scans use radiation, that MRI involves X-rays, that repeated scans inevitably cause cancer, or that ultrasound is harmful during pregnancy. Responses were recorded using a three-point Likert scale (Agree, Neutral, Disagree).

Section IV: Utilization Patterns
This section explored participants' previous exposure to diagnostic imaging, frequency of undergoing scans, reasons for investigations, whether imaging was physician-advised or self-requested, and awareness of radiation risks prior to undergoing tests.

Scoring Criteria
Awareness scores were calculated by summing correct responses and categorizing them as follows:

- Excellent (≥75% correct responses)
- Good (50–74%)
- Fair (25–49%)
- Poor (<25%)

Misconceptions were identified based on incorrect agreement with scientifically inaccurate statements. Utilization patterns were analyzed descriptively. Radiation literacy was operationally defined as the ability to correctly identify imaging modalities that involve ionizing radiation versus those that do not.

Validation and Reliability
The questionnaire underwent content and face validation by an expert panel comprising a radiologist, a public health specialist, and a biostatistician to ensure clarity, relevance, and scientific accuracy. A pilot study was conducted among 40 respondents (excluded from the final analysis) to assess clarity and internal consistency. Reliability analysis using Cronbach's alpha demonstrated good internal consistency ($\alpha \geq 0.80$).

Data Management and Statistical Analysis
Responses were automatically recorded in Google Forms and exported to Microsoft Excel for data cleaning and coding. Statistical analysis was performed using IBM SPSS Statistics (Version 26.0).
Descriptive statistics including frequency, percentage, mean, and standard deviation were used to summarize socio-demographic characteristics, awareness levels, misconceptions, and utilization patterns. Inferential analysis was conducted using the Chi-square test to evaluate associations between awareness levels and socio-demographic variables. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations
The study protocol was reviewed and approved by the Institutional Ethics Committee prior to commencement. Participation was entirely voluntary, and digital informed consent was obtained before proceeding with the questionnaire. Anonymity and confidentiality were strictly maintained throughout the study.

RESULTS
Among 420 participants, the largest age group was 26–35 years (29.0%), followed by 18–25 years (23.3%) and 36–45 years (22.4%), with 8.1% aged >60 years. Females constituted 53.3% of the sample. Educational attainment was high, with graduates (42.4%) and postgraduates (38.1%) forming the majority. Service/professional workers were the dominant occupational group (38.6%), and most participants reported a monthly household income between ₹25,001–50,000 (32.9%) or ₹50,001–75,000 (28.1%). Urban residents comprised 71.9% of the respondents, indicating a predominantly urban study population.

Table 1. Socio-Demographic Characteristics of Study Participants (n = 420)

Variable	Category	Frequency (n)	Percentage (%)
Age Group (years)	18–25	98	23.3
	26–35	122	29.0
	36–45	94	22.4
	46–60	72	17.1
	>60	34	8.1

Gender	Male	196	46.7
	Female	224	53.3
Educational Level	Up to Secondary (≤10+2)	82	19.5
	Graduate	178	42.4
	Postgraduate & Above	160	38.1
Occupation	Student	64	15.2
	Service/Professional	162	38.6
	Homemaker	96	22.9
	Self-employed/Business	68	16.2
	Retired/Unemployed	30	7.1
Monthly Household Income (INR)	<25,000	76	18.1
	25,001–50,000	138	32.9
	50,001–75,000	118	28.1
	>75,000	88	21.0
Area of Residence	Urban	302	71.9
	Semi-Urban	118	28.1

Overall awareness of diagnostic imaging modalities was moderate to good, with high correctness for ultrasound use in pregnancy (83.8%), the principle of ultrasound (81.9%), chest X-ray indication (80.0%), and identifying ultrasound as the safest modality in terms of radiation exposure (79.0%). Knowledge was also strong regarding X-ray involving ionizing radiation (75.7%) and the role of lead aprons in reducing exposure (73.8%). However, relatively lower correct responses were observed for nuclear medicine concepts (51.9%), PET scan utility (53.8%), and the definition of radiation dose (51.0%), indicating gaps in understanding advanced imaging and radiation metrics.

Table 2. Awareness Regarding Diagnostic Imaging Modalities Among the General Population of Punjab (n = 420)

Q No.	Question	Options	Correct n (%)
1	X-ray imaging uses which type of energy?	a) Sound waves b) Magnetic field **c) Ionizing radiation** d) Infrared rays	318 (75.7)
2	Ultrasound imaging works on the principle of	a) Radiation beams **b) Sound waves** c) Magnetic resonance d) Laser energy	344 (81.9)
3	Which imaging modality does **NOT** use ionizing radiation?	a) CT scan b) X-ray **c) MRI** d) Fluoroscopy	276 (65.7)
4	CT scan exposes the body to	a) No radiation b) Sound waves **c) Ionizing radiation** d) Only magnets	298 (71.0)
5	MRI primarily uses	a) X-rays b) Gamma rays **c) Strong magnetic field and radio waves** d) Ultrasound waves	264 (62.9)
6	Which imaging test is commonly used during pregnancy?	a) CT scan b) Nuclear scan **c) Ultrasound** d) PET scan	352 (83.8)
7	Contrast agents are used in imaging to	a) Reduce radiation **b) Improve image clarity** c) Shorten scan time d) Replace radiation	286 (68.1)
8	Repeated CT scans may increase	a) Bone density **b) Radiation exposure** c) Hair growth d) Blood pressure	304 (72.4)
9	Nuclear medicine scans involve	a) Sound waves **b) Injection of radioactive material** c) Only magnets d) Infrared rays	218 (51.9)
10	A chest X-ray is commonly used to detect	a) Kidney stones **b) Lung infections** c) Brain tumors d) Skin disease	336 (80.0)
11	MRI is especially useful for imaging	**a) Soft tissues and brain** b) Teeth c) Nails d) Hair follicles	302 (71.9)
12	Compared to a plain X-ray, CT scan radiation exposure is	a) Same b) Lower **c) Higher** d) None	244 (58.1)

13	Not all imaging tests involve radiation.	**a) True** b) False	268 (63.8)
14	Lead aprons are used during X-rays to	a) Improve clarity **b) Reduce radiation exposure** c) Increase contrast d) Speed scan	310 (73.8)
15	Imaging tests should ideally be performed	a) On patient demand b) Routinely every year **c) When medically indicated** d) For mild discomfort always	358 (85.2)
16	PET scan is primarily used for	a) Fractures **b) Cancer detection and metabolic activity** c) Vision testing d) Dental imaging	226 (53.8)
17	Which imaging modality is safest in terms of radiation exposure?	a) CT scan b) X-ray **c) Ultrasound** d) Fluoroscopy	332 (79.0)
18	Radiation exposure risk is higher in	a) Adults only **b) Children compared to adults** c) Elderly only d) Same in all ages	248 (59.0)
19	MRI scanning is generally avoided in patients with	a) Diabetes b) Hypertension **c) Metallic implants or pacemakers** d) Asthma	272 (64.8)
20	In diagnostic imaging, the term “radiation dose” refers to	a) Scan duration b) Cost of scan **c) Amount of radiation absorbed by the body** d) Image quality	214 (51.0)

Misconceptions and perceptions showed mixed patterns, with substantial correct disagreement toward common myths such as “ultrasound harms the foetus” (75.7%) and “all imaging tests use harmful radiation” (63.8%). A majority also correctly supported protective shielding during X-rays (73.8%) and acknowledged that doctors consider radiation risk before advising scans (76.7%). Nonetheless, weaker correctness was seen for statements reflecting uncertainty about overuse of imaging (47.1%) and misconceptions related to MRI risk and contrast safety, demonstrating persistent gaps in public radiation literacy and modality differentiation.

Table 3. Misconceptions and Perceptions Regarding Diagnostic Imaging Modalities Among the General Population of Punjab (n = 420)

Q No.	Statement	Response Options	Correct Response n (%)
1	All imaging tests use harmful radiation.	**a) Disagree** b) Neutral c) Agree	268 (63.8)
2	MRI uses X-rays to produce images.	**a) Disagree** b) Neutral c) Agree	254 (60.5)
3	Ultrasound is harmful to the fetus during pregnancy.	**a) Disagree** b) Neutral c) Agree	318 (75.7)
4	Repeated CT scans always cause cancer.	**a) Disagree** b) Neutral c) Agree	242 (57.6)
5	X-rays should be completely avoided even when medically necessary.	**a) Disagree** b) Neutral c) Agree	296 (70.5)
6	MRI is unsafe because it exposes patients to radiation.	**a) Disagree** b) Neutral c) Agree	262 (62.4)
7	Nuclear medicine scans involve radioactive substances.	a) Disagree b) Neutral **c) Agree**	226 (53.8)
8	Imaging tests are often overused without medical need.	a) Disagree **b) Neutral** c) Agree	198 (47.1)
9	Radiation from a single chest X-ray is extremely dangerous.	**a) Disagree** b) Neutral c) Agree	284 (67.6)
10	Protective shields reduce radiation exposure during X-rays.	a) Disagree b) Neutral **c) Agree**	310 (73.8)
11	MRI scans can cause electric shocks inside the body.	**a) Disagree** b) Neutral c) Agree	276 (65.7)
12	CT scans and MRI scans are the same type of test.	**a) Disagree** b) Neutral c) Agree	248 (59.0)
13	Imaging tests should not be repeated under any circumstances.	**a) Disagree** b) Neutral c) Agree	272 (64.8)
14	Children are more sensitive to radiation than adults.	a) Disagree b) Neutral **c) Agree**	248 (59.0)
15	Contrast injections used in scans are always harmful.	**a) Disagree** b) Neutral c) Agree	238 (56.7)

16	MRI machines are dangerous because of loud noise only.	**a) Disagree** b) Neutral c) Agree	214 (51.0)
17	Frequent imaging guarantees better health outcomes.	**a) Disagree** b) Neutral c) Agree	290 (69.0)
18	Radiation exposure accumulates with repeated scans.	a) Disagree b) Neutral **c) Agree**	304 (72.4)
19	Imaging tests are unnecessary if symptoms are mild.	**a) Disagree** b) Neutral c) Agree	266 (63.3)
20	Doctors usually consider radiation risks before advising scans.	a) Disagree b) Neutral **c) Agree**	322 (76.7)

Utilization of diagnostic imaging was high, with 80.0% reporting having undergone at least one imaging test and 59.0% having had more than one imaging test in the past five years. X-ray was the most frequently experienced modality (43.3%), followed by ultrasound (67.6% ever undergone), CT (46.7%), and MRI (40.0%). Most imaging was physician-advised (71.9%), and 86.2% reported willingness to undergo imaging if recommended by a doctor. However, only 51.0% recalled being informed about radiation risks prior to CT/X-ray, and cost influenced imaging decisions for 52.9% of participants, reflecting notable counselling and affordability considerations.

Table 4. Utilization Patterns of Diagnostic Imaging Modalities Among the General Population of Punjab (n = 420)

Q No.	Question	Options	n (%)
1	Have you ever undergone any diagnostic imaging test?	**a) Yes** b) No	336 (80.0)
2	If yes, which imaging modality have you undergone most frequently?	**a) X-ray** b) Ultrasound c) CT scan d) MRI e) Nuclear scan	182 (43.3)
3	Have you undergone more than one imaging test in the past 5 years?	**a) Yes** b) No	248 (59.0)
4	What was the main reason for your most recent imaging test?	**a) Physician-advised** b) Self-requested c) Routine health check-up	302 (71.9)
5	Have you ever requested an imaging test without doctor advice?	a) Yes **b) No**	286 (68.1)
6	Were you informed about radiation risks before undergoing CT/X-ray?	**a) Yes** b) No c) Do not remember	214 (51.0)
7	Have you ever delayed an imaging test due to fear of radiation?	a) Yes **b) No**	276 (65.7)
8	Would you agree to undergo an imaging test if recommended by your doctor?	**a) Yes** b) No c) Not sure	362 (86.2)
9	Have you compared costs before undergoing imaging?	**a) Yes** b) No	238 (56.7)
10	Do you believe imaging tests are sometimes over-prescribed?	a) Yes **b) Not sure** c) No	188 (44.8)
11	Have you ever undergone a CT scan?	**a) Yes** b) No	196 (46.7)
12	Have you ever undergone an MRI scan?	**a) Yes** b) No	168 (40.0)
13	Have you ever undergone an ultrasound examination?	**a) Yes** b) No	284 (67.6)
14	Have you undergone imaging in a government facility?	**a) Yes** b) No	198 (47.1)
15	Have you undergone imaging in a private diagnostic centre?	**a) Yes** b) No	264 (62.9)
16	Did cost influence your decision to undergo imaging?	**a) Yes** b) No	222 (52.9)
17	Do you keep records of your previous imaging reports?	**a) Yes** b) No	254 (60.5)
18	Have you ever refused an imaging test advised by a doctor?	a) Yes **b) No**	298 (71.0)

19	Would you undergo annual imaging as preventive screening without symptoms?	a) Yes **b) No** c) Not sure	244 (58.1)
20	Do you feel adequately informed before undergoing imaging tests?	**a) Yes** b) No c) Not sure	226 (53.8)

Cumulative awareness scoring demonstrated that 22.9% of participants had excellent awareness (15–20), while 42.4% fell in the good category (10–14). About one-quarter showed fair awareness (24.3%), and 10.4% had poor awareness (<5). The mean awareness score was 13.4 ± 3.2, indicating overall satisfactory knowledge with a measurable subgroup still requiring targeted education.

Table 5. Overall Awareness Score Distribution of Diagnostic Imaging Modalities Among the General Population of Punjab (n = 420)

Awareness Level	Score Range (out of 20)	Participants (n)	Percentage (%)
Excellent (≥75%)	15–20	96	22.9
Good (50–74%)	10–14	178	42.4
Fair (25–49%)	5–9	102	24.3
Poor (<25%)	0–4	44	10.4
Mean ± SD Score	—	—	**13.4 ± 3.2**

Misconception scoring indicated that 21.0% of respondents had low misconception levels (high accuracy, 15–20), while 45.2% demonstrated moderate misconception scores (10–14). A further 22.4% showed fair understanding (5–9), and 11.4% fell into the high misconception category (<5). The mean misconception score of 12.8 ± 3.4 suggests that while many participants could correctly identify factual statements, a substantial proportion still retained incorrect beliefs about imaging safety and radiation.

Table 6. Overall Misconception Score Distribution Regarding Diagnostic Imaging Modalities Among the General Population of Punjab (n = 420)

Misconception Level	Score Range (out of 20)*	Participants (n)	Percentage (%)
Low Misconception (High Accuracy ≥75%)	15–20	88	21.0
Moderate Misconception (50–74%)	10–14	190	45.2
Fair Understanding (25–49%)	5–9	94	22.4
High Misconception (<25%)	0–4	48	11.4
Mean ± SD Score	—	—	**12.8 ± 3.4**

Utilization scoring revealed that 20.0% of participants demonstrated appropriate utilization (15–20), and nearly half (46.7%) showed moderate utilization (10–14). Low utilization was observed in 21.9%, while 11.4% had poor or inappropriate utilization (<5). The mean utilization score was 12.6 ± 3.7, reflecting reasonable compliance with physician advice but incomplete translation of knowledge into consistently informed imaging behaviour.

Table 7. Overall Utilization Pattern Score Distribution of Diagnostic Imaging Modalities Among the General Population of Punjab (n = 420)

Utilization Level	Score Range (out of 20)	Participants (n)	Percentage (%)
Appropriate Utilization (≥75%)	15–20	84	20.0
Moderate Utilization (50–74%)	10–14	196	46.7
Low Utilization (25–49%)	5–9	92	21.9
Poor / Inappropriate Utilization (<25%)	0–4	48	11.4
Mean ± SD Score	—	—	**12.6 ± 3.7**

Awareness level showed statistically significant associations with age (p=0.008), education (p<0.001), occupation (p=0.011), and monthly income (p=0.018), indicating higher awareness among older, more educated, professionally employed, and higher-income respondents. Gender showed no significant association (p=0.602), and area of residence was also not significant (p=0.074), although urban participants demonstrated comparatively better awareness trends.

Table 8. Association Between Socio-Demographic Variables and Awareness Level of Diagnostic Imaging Modalities Among the General Population of Punjab (n = 420)

Variable	Category	Excellent n (%)	Good n (%)	Fair n (%)	Poor n (%)	χ^2 value	p-value

Age Group (years)	18–25 (n=98)	14 (14.3)	38 (38.8)	30 (30.6)	16 (16.3)	13.72	0.008*
	26–35 (n=122)	26 (21.3)	54 (44.3)	30 (24.6)	12 (9.8)		
	36–45 (n=94)	24 (25.5)	40 (42.6)	20 (21.3)	10 (10.6)		
	46–60 (n=72)	20 (27.8)	28 (38.9)	16 (22.2)	8 (11.1)		
	>60 (n=34)	12 (35.3)	18 (52.9)	2 (5.9)	2 (5.9)		
Gender	Male (n=196)	42 (21.4)	84 (42.9)	48 (24.5)	22 (11.2)	1.86	0.602
	Female (n=224)	54 (24.1)	94 (42.0)	54 (24.1)	22 (9.8)		
Education Level	Up to Secondary (n=82)	8 (9.8)	26 (31.7)	30 (36.6)	18 (22.0)	27.94	<0.001*
	Graduate (n=178)	34 (19.1)	78 (43.8)	46 (25.8)	20 (11.3)		
	Postgraduate & Above (n=160)	54 (33.8)	74 (46.3)	26 (16.3)	6 (3.6)		
Occupation	Student (n=64)	10 (15.6)	26 (40.6)	20 (31.3)	8 (12.5)	16.48	0.011*
	Service/Professional (n=162)	46 (28.4)	70 (43.2)	32 (19.8)	14 (8.6)		
	Homemaker (n=96)	18 (18.8)	38 (39.6)	28 (29.2)	12 (12.5)		
	Self-employed (n=68)	16 (23.5)	28 (41.2)	18 (26.5)	6 (8.8)		
	Retired/Unemployed (n=30)	6 (20.0)	16 (53.3)	4 (13.3)	4 (13.3)		
Monthly Income (INR)	<25,000 (n=76)	10 (13.2)	26 (34.2)	26 (34.2)	14 (18.4)	14.63	0.018*
	25,001–50,000 (n=138)	26 (18.8)	62 (44.9)	36 (26.1)	14 (10.1)		
	50,001–75,000 (n=118)	28 (23.7)	52 (44.1)	26 (22.0)	12 (10.2)		
	>75,000 (n=88)	32 (36.4)	38 (43.2)	14 (15.9)	4 (4.5)		
Area of Residence	Urban (n=302)	78 (25.8)	132 (43.7)	68 (22.5)	24 (8.0)	6.92	0.074
	Semi-Urban (n=118)	18 (15.3)	46 (39.0)	34 (28.8)	20 (16.9)		

*Significant at $p < 0.05$
*Highly Significant at $p < 0.001$

Misconception level was significantly associated with age (p=0.011), education (p<0.001), occupation (p=0.014), and income (p=0.022), suggesting that higher educational status, better occupational standing, and higher income were linked to fewer misconceptions. Gender remained non-significant (p=0.628), and residence did not show a statistically significant association (p=0.068), though semi-urban respondents tended to have higher misconception proportions.

Table 9. Association Between Socio-Demographic Variables and Misconception Level Regarding Diagnostic Imaging Modalities Among the General Population of Punjab (n = 420)

Variable	Category	Low Misconception n (%)	Moderate n (%)	Fair n (%)	High n (%)	χ^2 value	p-value
Age Group (years)	18–25 (n=98)	14 (14.3)	42 (42.9)	26 (26.5)	16 (16.3)	12.96	0.011*
	26–35 (n=122)	24 (19.7)	60 (49.2)	26 (21.3)	12 (9.8)		
	36–45 (n=94)	22 (23.4)	44 (46.8)	18 (19.1)	10 (10.6)		
	46–60 (n=72)	18 (25.0)	30 (41.7)	16 (22.2)	8 (11.1)		

	>60 (n=34)	10 (29.4)	14 (41.2)	8 (23.5)	2 (5.9)		
Gender	Male (n=196)	40 (20.4)	90 (45.9)	42 (21.4)	24 (12.2)	1.74	0.628
	Female (n=224)	48 (21.4)	100 (44.6)	52 (23.2)	24 (10.7)		
Education Level	Up to Secondary (n=82)	8 (9.8)	28 (34.1)	30 (36.6)	16 (19.5)	26.38	<0.001*
	Graduate (n=178)	30 (16.9)	86 (48.3)	42 (23.6)	20 (11.2)		
	Postgraduate & Above (n=160)	50 (31.3)	76 (47.5)	22 (13.8)	12 (7.4)		
Occupation	Student (n=64)	10 (15.6)	30 (46.9)	16 (25.0)	8 (12.5)	15.87	0.014*
	Service/Professional (n=162)	44 (27.2)	76 (46.9)	28 (17.3)	14 (8.6)		
	Homemaker (n=96)	14 (14.6)	42 (43.8)	26 (27.1)	14 (14.6)		
	Self-employed (n=68)	14 (20.6)	30 (44.1)	18 (26.5)	6 (8.8)		
	Retired/Unemployed (n=30)	6 (20.0)	12 (40.0)	6 (20.0)	6 (20.0)		
Monthly Income (INR)	<25,000 (n=76)	10 (13.2)	30 (39.5)	22 (28.9)	14 (18.4)	13.92	0.022*
	25,001–50,000 (n=138)	22 (15.9)	68 (49.3)	34 (24.6)	14 (10.2)		
	50,001–75,000 (n=118)	24 (20.3)	54 (45.8)	30 (25.4)	10 (8.5)		
	>75,000 (n=88)	32 (36.4)	38 (43.2)	8 (9.1)	10 (11.3)		
Area of Residence	Urban (n=302)	70 (23.2)	142 (47.0)	64 (21.2)	26 (8.6)	7.12	0.068
	Semi-Urban (n=118)	18 (15.3)	48 (40.7)	30 (25.4)	22 (18.6)		

*Significant at p < 0.05
*Highly Significant at p < 0.001
Utilization pattern showed significant associations with age (p=0.019), education (p<0.001), occupation (p=0.009), and income (p=0.014), demonstrating that appropriate utilization was more common among better educated and higher-income participants. Gender was not significantly associated with utilization (p=0.664), and area of residence was also non-significant (p=0.058), though urban respondents showed a slightly higher proportion of appropriate utilization compared to semi-urban participants.

Table 10. Association Between Socio-Demographic Variables and Utilization Pattern of Diagnostic Imaging Modalities Among the General Population of Punjab (n = 420)

Variable	**Category**	**Appropriate n (%)**	**Moderate n (%)**	**Low n (%)**	**Poor n (%)**	**χ^2 value**	**p-value**
Age Group (years)	18–25 (n=98)	16 (16.3)	44 (44.9)	22 (22.4)	16 (16.3)	11.84	0.019*
	26–35 (n=122)	28 (23.0)	62 (50.8)	20 (16.4)	12 (9.8)		
	36–45 (n=94)	22 (23.4)	48 (51.1)	16 (17.0)	8 (8.5)		
	46–60 (n=72)	18 (25.0)	34 (47.2)	14 (19.4)	6 (8.4)		
	>60 (n=34)	8 (23.5)	16 (47.1)	6 (17.6)	4 (11.8)		
Gender	Male (n=196)	40 (20.4)	96 (49.0)	36 (18.4)	24 (12.2)	1.58	0.664
	Female (n=224)	52 (23.2)	108 (48.2)	42 (18.8)	22 (9.8)		
Education Level	Up to Secondary (n=82)	8 (9.8)	30 (36.6)	26 (31.7)	18 (22.0)	29.46	<0.001 *
	Graduate (n=178)	34 (19.1)	94 (52.8)	34 (19.1)	16 (9.0)		
	Postgraduate & Above (n=160)	50 (31.3)	80 (50.0)	18 (11.2)	12 (7.5)		
Occupation	Student (n=64)	10 (15.6)	30 (46.9)	16 (25.0)	8 (12.5)	16.92	0.009*
	Service/Professional (n=162)	44 (27.2)	82 (50.6)	22 (13.6)	14 (8.6)		

	Homemaker (n=96)	16 (16.7)	48 (50.0)	22 (22.9)	10 (10.4)		
	Self-employed (n=68)	16 (23.5)	32 (47.1)	14 (20.6)	6 (8.8)		
	Retired/Unemployed (n=30)	6 (20.0)	12 (40.0)	4 (13.3)	8 (26.7)		
Monthly Income (INR)	<25,000 (n=76)	10 (13.2)	30 (39.5)	20 (26.3)	16 (21.0)	15.88	0.014*
	25,001–50,000 (n=138)	26 (18.8)	72 (52.2)	28 (20.3)	12 (8.7)		
	50,001–75,000 (n=118)	26 (22.0)	60 (50.8)	22 (18.6)	10 (8.6)		
	>75,000 (n=88)	30 (34.1)	42 (47.7)	8 (9.1)	8 (9.1)		
Area of Residence	Urban (n=302)	74 (24.5)	150 (49.7)	48 (15.9)	30 (9.9)	7.48	0.058
	Semi-Urban (n=118)	18 (15.3)	54 (45.8)	30 (25.4)	16 (13.5)		

*Significant at $p < 0.05$
*Highly Significant at $p < 0.001$

Correlation analysis revealed statistically significant positive relationships among awareness, misconception, and utilization scores. Awareness correlated moderately with misconception score (r=0.482, p<0.01), indicating that higher awareness was associated with fewer misconceptions. Awareness also showed the strongest correlation with utilization (r=0.536, p<0.01), suggesting that better knowledge translated into more appropriate imaging behaviour. Misconception score was also positively correlated with utilization (r=0.418, p<0.01), reinforcing that reduced misconceptions are linked to improved utilization practices.

Table 11. Correlation Between Awareness, Misconception, and Utilization Scores Among the General Population of Punjab (n = 420)

Variables	Awareness Score	Misconception Score	Utilization Score
Awareness Score	1	0.482**	0.536**
Misconception Score	0.482**	1	0.418**
Utilization Score	0.536**	0.418**	1

Pearson's Correlation Coefficient (r)
**** Correlation is significant at the 0.01 level (2-tailed)**

DISCUSSION

This community-based cross-sectional study provides a detailed snapshot of how the general population of Punjab understands diagnostic imaging, the misconceptions they hold, and how these factors translate into real-world utilization behaviour. Overall, the findings highlight a consistent pattern: awareness of commonly used modalities is reasonably good, but deeper radiation literacy and understanding of advanced imaging remain limited, and this knowledge gap is reflected in incomplete counselling and mixed utilization practices.

Awareness of imaging modalities: good familiarity, limited depth

Participants demonstrated stronger knowledge for widely encountered tests such as ultrasound and X-ray. High correct responses for ultrasound use in pregnancy (83.8%), the principle of ultrasound (81.9%), chest X-ray utility (80.0%), and identifying ultrasound as safest in terms of radiation exposure (79.0%) suggest that repeated community exposure to these modalities has improved practical familiarity. Similarly, three-fourths correctly identified that X-rays involve ionizing radiation (75.7%) and recognized the protective role of lead aprons (73.8%), indicating meaningful baseline understanding of radiation safety measures.
However, awareness declined when questions required technical differentiation or understanding of less commonly discussed modalities. Correct responses were comparatively low for nuclear medicine (51.9%), PET scan utility (53.8%), and the definition of radiation dose (51.0%). This pattern suggests that the public's knowledge is largely experience-driven—strong for tests they commonly undergo or hear about, but weaker for advanced modalities that are less frequently used, costlier, or typically discussed only during specialized care. Importantly, only 58.1% correctly acknowledged that CT generally involves higher radiation exposure than plain X-ray, reflecting incomplete understanding of relative radiation burden—an area central to patient counselling and risk communication.

Misconceptions: persistent myths influence risk perception

Although many respondents appropriately rejected major myths—such as ultrasound harming the foetus (75.7%) or the belief that all imaging tests involve harmful radiation (63.8%)—misconceptions remained prevalent overall, as reflected by the misconception score distribution. Nearly half of the participants fell into the moderate misconception category (45.2%), and 11.4% exhibited high misconception scores, indicating vulnerability to misinformation and misunderstandings about imaging safety.

Two aspects are particularly important. First, uncertainty about imaging overuse was substantial, with the lowest correctness noted for "imaging tests are often overused without medical need" (47.1%). This may reflect limited public understanding of clinical appropriateness criteria and the difference between medically justified imaging and unnecessary over-investigation. Second, misconceptions related to MRI safety and contrast risks persisted. These misconceptions can contribute to anxiety, avoidance, or delayed imaging—especially when patients associate all scans with radiation or assume contrast agents are uniformly harmful. Such fear-based perceptions have practical consequences in healthcare delivery, particularly in time-sensitive conditions where delayed imaging can compromise outcomes.

Utilization patterns: high uptake, but counseling and informed decision-making gaps

Imaging utilization was high in this population: 80.0% reported having undergone an imaging test, and 59.0% had more than one imaging test within the past five years. This indicates substantial reliance on diagnostic imaging in routine healthcare and suggests improved access across Punjab. X-ray was the most commonly experienced modality (43.3%), consistent with its availability, affordability, and routine use in trauma and respiratory illnesses. Ultrasound exposure was also high (67.6%), reflecting its role in abdominal complaints and obstetric care, while CT (46.7%) and MRI (40.0%) utilization suggests increasing access to advanced imaging.

A positive finding is strong trust in physician guidance: 71.9% underwent imaging primarily on physician advice and 86.2% expressed willingness to undergo imaging when recommended. Additionally, 68.1% reported not requesting imaging without medical advice, suggesting that self-driven overutilization may not be dominant in this cohort. Nevertheless, important gaps were observed. Only 51.0% recalled being informed about radiation risks before CT/X-ray, indicating that risk communication and consent-related cong may be inconsistently practiced or poorly retained. In settings where imaging is frequent, counselling must not only be provided but also communicated clearly in patient-friendly language to ensure informed decision-making.

Cost considerations also emerged as a key influence, with 52.9% reporting that cost affected their imaging decisions and 56.7% comparing prices before testing. This highlights the financial sensitivity surrounding diagnostic investigations and underscores the need for transparent pricing, rational test selection, and public sector strengthening. Notably, 58.1% did not favor annual imaging without symptoms, which supports the presence of some rational health behaviour and suggests an opportunity for reinforcing evidence-based screening awareness.

Awareness–misconception–utilization relationship: knowledge drives behavior

The correlation analysis strengthens the interpretive value of this study by demonstrating that awareness and misconception scores are not isolated measures; they influence utilization patterns. Awareness showed a moderate positive correlation with misconception score ($r=0.482$), indicating that higher awareness aligns with fewer misconceptions. Awareness also showed the strongest relationship with utilization ($r=0.536$), suggesting that people who understand imaging better are more likely to use it appropriately. The positive correlation between misconception score and utilization ($r=0.418$) further confirms that correcting myths can improve imaging-related decision-making.

Taken together, these relationships support a clear public health message: improving imaging literacy is likely to enhance rational utilization and reduce fear-driven avoidance. This is particularly relevant in the context of radiation-related anxiety, where misinformation often spreads faster than scientific clarification.12-14

Socio-demographic determinants: education and income consistently matter

Across awareness, misconception, and utilization domains, education emerged as the strongest and most consistent predictor ($p<0.001$ in association tables). Participants with postgraduate education showed higher excellent awareness, lower misconceptions, and more appropriate utilization. Income and occupation also showed significant associations, indicating that socioeconomic advantage may provide better healthcare exposure, access to reliable information, and stronger engagement with healthcare professionals. Age demonstrated significant associations as well, with younger age groups showing comparatively lower awareness and less appropriate utilization, potentially due to reduced healthcare exposure or greater reliance on informal online sources.

Gender was consistently non-significant across awareness, misconception, and utilization outcomes, suggesting that in this setting, access to information and healthcare utilization patterns may not differ substantially by sex. Residence (urban vs semi-urban) did not reach statistical significance, although trends favored urban respondents. This suggests that while access and exposure may differ across locations, educational and socioeconomic factors may be stronger drivers than geography alone, especially in an online survey sample that may inherently include more digitally connected respondents.6-9

Implications for practice and public health

The study findings carry direct practical implications. First, clinicians and radiology departments should strengthen communication strategies—particularly for CT and other radiation-involving tests—using standardized counseling points in simple language (e.g., what radiation is, relative dose comparison, why the test is needed, and what safety precautions are used). Second, misinformation about MRI, nuclear medicine, and contrast agents should be addressed through targeted public messaging. Third, since cost influences imaging decisions for many participants, policymakers should focus on affordability measures and guideline-based rational imaging to prevent both underuse (due to cost fear) and overuse (due to misinformation or patient demand in some contexts).4,7,9,14

Because education is strongly linked to outcomes, community-level campaigns should be designed for different literacy levels—using visual infographics, Punjabi language materials, and short myth-busting modules distributed through primary healthcare centres and digital platforms. Given the high trust in physician recommendations observed in this study, empowering physicians with quick counselling tools may have an immediate positive impact.3,8,12.

Strengths and limitations

A key strength of this study is its comprehensive approach, assessing awareness, misconceptions, and utilization together, and further examining socio-demographic associations and correlations among scores. The sample size (n=420) provides stable estimates and allows meaningful subgroup analysis.

However, certain limitations should be acknowledged. The Google Form-based approach may over represent educated, urban, and digitally active respondents, which could inflate awareness levels and limit generalizability to populations with lower digital access. Responses were self-reported, and recall bias may affect items such as whether participants were counselled about radiation. Additionally, utilization questions measured perceived behaviour rather than verified medical records. Future studies may benefit from mixed-method designs that include rural outreach, in-person sampling, and qualitative interviews to understand why misconceptions persist and how counselling can be improved

CONCLUSION

The general population of Punjab demonstrated moderate-to-good awareness of common diagnostic imaging modalities, particularly ultrasound and X-ray; however, significant gaps remain in understanding advanced imaging, nuclear medicine, PET, and radiation dose concepts. A notable proportion of participants continued to hold misconceptions related to imaging safety and radiation risks. Imaging utilization was high and predominantly physician-guided, reflecting strong trust in medical advice, yet only half of study participants recalled receiving radiation-related counselling, and in many cases cost of investigation influenced decisions. Education, occupation, income, and age were significant determinants of awareness, misconceptions, and utilization, while gender and residence were not. Higher awareness and fewer misconceptions were positively associated with more appropriate utilization. These findings underscore the need for focused public education and improved patient-centred communication to ensure rational, safe, and informed use of diagnostic imaging.

Recommendations

1. Strengthen patient counselling before radiation-based imaging: Standardized, brief, patient-friendly counselling (especially before CT and repeated X-rays) should be incorporated into routine practice, including simple explanations of necessity, relative radiation risk and safety precautions.
2. Community-focused radiation literacy campaigns: Health education materials in local language(s), with infographics and myth-busting messages, should address common misconceptions (e.g., MRI does not use X-rays, ultrasound safety in pregnancy, and when imaging repetition is justified).
3. Target advanced imaging misconceptions: Special emphasis should be placed on improving understanding of nuclear medicine, PET scans, contrast use, and the meaning of radiation dose, as these were areas of weaker knowledge.
4. Training for frontline healthcare providers: Physicians and primary healthcare staff should be equipped with quick communication tools to support informed decision-making and improve patient confidence.
5. Promote rational imaging and affordability: Since cost influenced imaging decisions for many participants, policies promoting transparent pricing, guideline-based imaging, and strengthening public sector diagnostic services are recommended.
6. Future research: Larger studies with rural and offline sampling, along with qualitative interviews, are recommended to capture underserved populations and explore reasons behind persistent misconceptions.

REFERENCES

1. Hussain S, Mubeen I, Ullah N, Shah SSUD, Khan BA, Zahoor M, Ullah R, Khan FA, Sultan MA. Modern Diagnostic Imaging Technique Applications and Risk Factors in the Medical Field: A Review. Biomed Res Int. 2022 Jun 6;2022:5164970.
2. Gupta S, Kaira P, Pathan S, Chidrawar K, Gondaliya KR, Toor SK. Emerging Trends in Diagnostic Radiology: Integrating Advanced Imaging Modalities for Early Detection, Clinical Monitoring, and Prognostic Evaluation of Multisystem Internal Medicine Disorders. Cureus. 2026 Jan 13;18(1):e101488.
3. Seth N, Sharma S, Verma S, Varshney DK, Kale P. Modern radiodiagnosis redefining diagnostic accuracy in healthcare: A narrative review. *IP Int J Maxillofac Imaging.* 2024;10(4):144-148.
4. Alreshidi MN, Alshubrmi D, Alreshidi F, Soliman K, Alrashidi I. Knowledge about imaging modalities, risks, and protection in radiology among medical students at the University of Hail. Avicenna J Med. 2020 Jan 23;10(1):15-21.
5. Atallah SS, Bagabas NA, Hemouda MH. Physician awareness about radiation and patient safety in radiology: A systematic review. *Sci Set J Cancer Res.* 2025;4(2):1-23.
6. Chia DM, Mohammad H, Ugande AA, Iorpagher PK. Evaluation of existing knowledge, perceptions and practices of diagnostic imaging among non-radiologist physicians in Makurdi, North-Central Nigeria. *Int J Res Med Sci.* 2022;10(11):2353.
7. Bárdyová Z, Horváthová M, Pinčáková K, Budošová D. The importance of public health in radiology and radiation protection. J Public Health Res. 2021 Mar 12;10(3):2141.
8. Asante S, Acheampong F. Patients' knowledge, perception, and experience during magnetic resonance imaging in Ghana: A single centre study. *Radiography.* 2021;27(2):622-626.
9. Nassanga R, Nakasujja N, Kaddumukasa M, Jones SE, Sajatovic M, Kawooya MG (2025) Perceptions and practices of imaging personnel and physicians regarding the use of brain MRI for dementia diagnosis in Uganda. PLoS ONE 20(1): e0305788.
10. Goyal S, Sakhi P, Kalidindi S, Nema D, Pakhare AP. Knowledge, Attitudes, Perceptions, and Practices Related to Artificial Intelligence in Radiology Among Indian Radiologists and Residents: A Multicenter Nationwide Study. Cureus. 2024 Dec 31;16(12):e76667.
11. Vukani N, Lindiwe G, Van Wyk B. Radiographers' awareness, understanding, and implementation of diagnostic reference levels in medical imaging: A scoping review. *J Med Imaging Radiat Sci.* 2025;56(6):102101.
12. Shakhreet BZ. Patient awareness and knowledge level for radiation in different radiology modalities in hospitals. *J Sci Res Rep.* 2021;27(3):84-92.
13. Chen J, Zheng J, Zhang Q, Zhang J, Dai Q, Zhang D. Radiation exposure in recurrent medical imaging: Identifying drivers and high-risk populations. *Front Public Health.* 2025;13:1626906.
14. Ahmad Saleh Mufarh Eid & Bashar Jamal Alnajjar. Radiation Safety and Patient Education in Diagnostic Imaging. Sch Acad J Biosci, 2025 Sep 13(9): 1307-1317.