Knowledge and Perception of Radiation Exposure by Patients in Diagnostic Radiology in Saudi Arabia 2024

Wedyan Hamdan Hawsawi[1], Mohammed Saad Alqahtani[2], Razan Shaye Alqahtani[3], Rajaa Abdullah Mahmoud[4], Najd Mohammad Al Saadi[5], Abdul Majeed Munif Bin Omayrah[6], Dais Sulaiman Dais Al Qahtani[2], Kabsh, Essa Mohammed A[7], Hussain Theeb Alhassan[8], Abdullah Ali Alharbi[9], Waleed Abdullah Ahmad Alqasmi[10]

1. Specialist-Radiological technology, Heraa general hospital, Saudi Arabia.
2. X-ray Technician, Rwaydahalard general hospital, Saudi Arabia.
3. Radiology Technician Al Ghadeer Health Center, Saudi Arabia.
4. Radiology Technician, King Abdulaziz Hospital, Saudi Arabia.
5. Radiology Technician ,King Faisal Hospital in Makkah, Saudi Arabia.
6. Radiology technician, Rawda Al-Ard Hospital, Saudi Arabia.
7. Radiological Technology, Jazan Health Cluster, Saudi Arabia.
8. Radiology Technician Al Wadi Health Center, Saudi Arabia.
9. Radiology Technician ,khulais PHC, Saudi Arabia, Saudi Arabia.
10. Radiological Technology Technician, Management alhajj and alumrah, Saudi Arabia.

Abstract
Background: Ionizing radiation is a helpful diagnostic tool in a wide range of medical specialties. However, it imposes a risk of radiation exposure to both patients and healthcare professionals. Patients need to know the advantages and disadvantages of ionizing radiation-based imaging procedures in order to give their informed permission. X-rays and computed tomography (CT) have a random lifetime risk of causing cancer. This risk is hard to explain and frequently disregarded. **The study aimed:** To assess patient knowledge and perception of medical imaging to facilitate an informed consent process. **Method:** A cross-sectional study was conducted in a general outpatient clinic in Jeddah, Saudi Arabia. Convenience sampling was used to distribute questionnaires during clinic hours from January to March 2024. **Results:**A total of 219 people responded. Only 6% were aware that natural background radiation poses a risk of cancer, whereas 22% were aware that CT generates ionizing radiation linked to cancer risk. Just 25% were aware that CT is more likely than X-rays to cause cancer. Most (93%) were aware that smoking is more dangerous than X-rays. Concern with X-rays was statistically linked to the Internet as a source of knowledge. **Conclusions:**Patients were unable to compare the danger of various imaging modalities and underestimated the risk of CT cancer. Using more well-known relatable dangers as comparators can help communicate risk more effectively. The patient groups who needed the most education were those with little information.
Keywords: X-ray, radiation, risk, knowledge, perception, attitude

Introduction:

Ionizing radiation is regarded as a non-invasive diagnostic technique [(1)], and it can assist in choosing a pharmaceutical or interventional approach for a medical disease[(2)]. A few methods, such as computed tomography (CT) scans, magnetic resonance imaging (MRI), and X-rays, involve ionizing radiation [(3)]. Healthcare workers and patients are the ones who are most exposed to ionizing radiation during the intervention, whether it is for diagnostic or therapeutic reasons [(4)]. A dosimeter can be used to easily determine the radiation exposures [(5)]. However, when using a dosimeter to measure radiation exposure, it is impossible to see the radiation dosage directly with the naked eye for patients or medical personnel [(6)].Patients must be educated to reduce their risk of cancer or other radiation exposure concerns, even if medical personnel in radiological fields have excellent training in radiation safety [(7, 8)].

According to the linear no threshold model, X-rays and computed tomography (CT), imaging procedures that use ionizing radiation, have a stochastic lifetime risk of causing cancer [(9, 10)]. In order to provide patient-centered treatment, patients must understand both the dangers and the advantages of this type of imaging. This information should be included in an informed consent process because of its material importance to the patient [(11)]. A "patient centered imaging" framework, created by the American College of Cardiology, includes a risk-based imaging consent grading system[(12)].

Patients generally understand that CT scans entail radiation, according to studyconducted by Busey et al., (2013) [(13)], but they do not link this to an increased risk of cancer, according to another study conducted byLee et al., (2004)[(14)]. A lack of understanding has been demonstrated to exist between radiation dose and level of risk[15].Most patients in trials made a mistake when asked to directly compare the radiation dose from CT to X-ray [15, 16]. This may result from physicians' failure to adequately explain risk with patients [14], either by omission or from their own lack of expertise[12, 17]. In a research, most patients wanted to know the hazards associated with CT, although few were worried about it [13] because diagnosis was crucial [13, 15, 18].

Several studies have explored the level of knowledge of healthcare professionals toward diagnostic radiation hazards though there is lack of data about the level of knowledge of patients about the risk of ionizing radiation[19, 20]. Additionally, a cross-sectional survey conducted at King Fahad Medical City Hospital in Saudi Arabia showed that (20.8%) of the patients knew that radiation might lead to cancer, and (49.3%) of them believed it could cause fetal anomalies [21]. Therefore,this study aimed to assess patient knowledge, perception, and attitude toward X-ray radiation risk to facilitate the consent process.

Methods

A cross-sectional study was conducted in a general outpatient clinic in Jeddah, Saudi Arabia. Convenience sampling was used to distribute questionnaires during clinic hours from January to March 2024. The study was approved by ethical committee.Eligibility criteria were to be over 16 years old, translate the questionnaire intoArabic. Patients were approached in the clinic waiting room, where the purpose of the study was explained and informed consent obtained. Patients were given a paper questionnaire and asked to hand it back when complete. Assistance to complete the questionnaire was not offered but given if specifically requested for reading or writing.

Descriptive analysis was done in Microsoft Excel (16.0). IBM SPSS version 28 was used for cross-tabulation and X^2 analysis. The critical level of significance was 0.05 (5%). For analysis of associations, conversion to binary variables was done as follows. Age was categorized into ≤ 30 and >30 years old. Pain was categorized into “No pain” (0 on the pain scale) and “Pain” (1-10 on the pain scale). To create a binary variable describing patient knowledge of radiation risk, correct answers to questions 6 and 7 were summed for each respondent, then knowledge was categorized as “low” (score of 0- 3) and “high” (score of 4-10).

Rather than an arbitrary choice, the cutoff was based on consideration of question difficulty, with knowledge of X-ray, CT, and sun radiation risk perceived to be fairly straightforward questions (3 easier questions, hence 0-3 category), whereas background radiation in air and probability questions were harder. For Q8, which graded the amount of danger perceived in X-rays, any positive answer given was lumped into a single “yes” category. Answers to other questions were already binary, that is, a patient had either indicated they receive health information from a particular source, such as from a “doctor,” or they had not.

Results

Two hundred and fifty patients were assessed for eligibility; 8 failed to meet inclusion criteria. Completed questionnaires were received from 219 of the 242 eligible patients, giving a response rate of 90.5%.The mean age of respondents was 48.2 years (n = 214, standard deviation = 17.79, min = 16, max = 88). Fifty-six percent (n = 217) were male; 98% (n = 218) had an X-ray in the past; and 91% (n = 217) indicated they were in pain.

The responses to Q6 (Do any of the following produce radiation that may lead to cancer at a later age?) were as follows: sun 76%, X-ray 53%, mobile phone 37%, CT 22%, magnetic resonance imaging (MRI) 20%, air 7%, ultrasound 6% (n 219). Table (1) shows the responses to Q7 assessing knowledge of lifetime cancer risk (or risk of death for a road accident) from common imaging techniques and from other causes.

Table (1): Distribution of Assigned Risk Probabilities (% Respondents) to Scenarios in Q7.[a]

Scenario	Risk								
	1/3	1/10	1/100	1/1000	$1/1\times10^5$	$1/1\times10^6$	0	Don’tKnow	n
CancerfromarmX-ray	2	1	2	4	15	25*	15	35	213
CancerfromspineCT	1	1	3	6*	11	13	16	48	211
CancerfromMRI	0	2	2	6	9	13	24*	43	211
Canceringeneral	22*	22	11	15	12	3	0	14	214
Cancerfromsmoking	26	26*	15	15	5	1	0	11	212
Dyinginaroadaccident	4	10	16*	21	25	8	1	16	212

Abbreviations:CT,computedtomography;MRI,magneticresonanceimaging.

[a]Correctanswerdenotedbyasterisk(*).The3mostfrequentlypickedanswersarehighlightedingrey.

Table (2) shows Responses to questions about perception and attitude toward imaging

Table (2): Responses to Q8-16 about perception of danger and attitude toward X-Rays

Question	n	% Yes
Q8. Do you consider X-rays as dangerous? [a]	214	53
Q9. Do you have any worries or concerns abouthaving an X-ray? [b]	214	11
Q11. Have you ever refused an X-ray that the doctor recommended, due to your concern?	214	1.4
Q12. Do you consider nuclear power plants asacceptable?	207	50
Q13. Have you ever thought you needed an X-ray, but not had one carried out?	212	22
Q14. Should the patient have the final say (rather than the doctor) on deciding whether to have an X-ray?	212	52
Q15. If a new X-ray machine were available that usedsignificantly less radiation, would you be prepared totravel an extra 50 miles to a hospital with thistechnology?	212	38
Q16. If a new X-ray machine were available thatproduced better quality imaging, would you beprepared to travel an extra 50 miles to a hospitalwith this technology?	211	64

[a] Danger categories ¼ 44% low, 8% medium, 1% high.

[b] Content analysis of written answers (to Q10) detailing the concernrevealed that 5% mentioned cancer, 45% mentioned radiation, and 10%mentioned both.

Table (3) shows the relationship between 11 risk factors and 3 dichotomous outcome variables see. Methods section for calculation. Risk factors which showed a statistically significant association with knowledge of radiation risk were age (those younger than 30 were 2.07 times as likely to have better knowledge relative to those over 30, *P* < .01), obtaining health information from a doctor (those who obtained health information from a doctor were 0.58 times as likely to have better knowledge, *P* =.03) or general knowledge (those who obtained health information from general knowledge were1.94 times as likely to have better knowledge, *P* < .01) ortaught knowledge (those who obtained health informationfrom taught knowledge were 2.36 times as likely to have better knowledge, P < .01), and pain (those who were in painwere 0.43 times as likely to have better knowledge, P < .01).

Risk factors which showed a statistically significant association with perception of X-rays as dangerous were sex(females were 1.4 times as likely to perceive danger, P ¼.01), obtaining health information from a doctor (those whoobtained health information from a doctor were 0.72 times aslikely to perceive danger, P ¼ .03) or taught knowledge(those who obtained health information from taught knowledge were 1.57 times as likely to perceive danger, P < .01),and knowledge level (those who had a high level of knowledge were 1.4 times as likely to perceive danger, P ¼ .01).The only risk factor to show a statistically significantassociation with concern about X-rays was using the Internetas a source of health information (patients who obtainedhealth info from the Internet were 2.17 times as likely tobe concerned about X-rays, P ¼ .03).

Table (3): Relative Risk of Outcome Variables for Risk Factors (Unadjusted).[a]

		OutcomeVariables					
		KnowledgeofRadiationRisk: HighVersusLow		**Perceive X-Rays as Dangerous:YesVersusNo**		**ConcernAboutX-Rays:YesVersusNo**	
RiskFactors		**RR(95%CI)**	***P***	**RR(95%CI)**	***P***	**RR(95%CI)**	***P***
Age (years)Sex	≤30vs>30	2.07(1.35-3.17) 0.96(0.61-1.52)	.00 .88	1.04(0.77-1.41) 1.40(1.09-1.78)	.79 .01	0.53(0.17-1.67) 1.60(0.79-3.25)	.26 .19
Healthinfofrom							
Doctor	YvsN	0.58(0.37-0.91)	.03	0.72(0.56-0.93)	.03	0.92(0.37-2.27)	.86
GeneralKnowledge	YvsN	1.94(1.27-2.96)	.00	1.23(0.96-1.58)	.12	0.92(0.41-2.06)	.84
TaughtKnowledge	YvsN	2.36(1.56-3.57)	.00	1.57(1.25-1.98)	.00	1.41(0.61-3.25)	.42
Internet	YvsN	1.08(0.69-	.75	1.19(0.93-1.52)	.16	2.17(1.04-4.52)	.03

		OutcomeVariables					
		KnowledgeofRadiationRisk: HighVersusLow		Perceive X-Rays as Dangerous:YesVersusNo		ConcernAboutX-Rays:YesVersusNo	
RiskFactors		RR(95%CI)	*P*	RR(95%CI)	*P*	RR(95%CI)	*P*
		1.67)					
Reading	YvsN	1.28(0.79-2.08)	.33	1.27(0.99-1.64)	.09	1.83(0.88-3.80)	.11
TV	YvsN	1.14(0.53-2.45)	.74	1.17(0.78-1.74)	.49	2.15(0.85-5.46)	.12
Wordofmouth	YvsN	1.15(0.63-2.07)	.66	0.95(0.65-1.38)	.77	1.11(0.41-2.98)	.84
Pain	YvsN	0.43(0.27-0.68)	.00	1.03(0.66-1.61)	.90	1.22(0.31-4.76)	.77
Knowledge	Highvslow	—		1.40(1.10-1.78)	.01	0.79(0.34-1.89)	.60

Abbreviations:CI,confidenceinterval;F,female;M,male;N,No;RR,relativerisk;Y,yes.

[a]Foreachriskfactor,thereferencecategoryisthecomparator,forexample,foragethereferencecategoryis>30;nvariesfrom208to214.

Discussion:

The multiple national government and charity skin cancer campaigns in the UK contributed to a good understanding of the sun's association with cancer risk, which the Office of National Statistics has shown to have a quantifiable effect. This might be repeatable in other nations with comparable campaigns, such Australia. Many more patients were aware of the connection between X-rays and cancer than CT; this is believed to be because CT is more recent, meaning there is less time for learning about it and possibly a perception that newer technology is safer. The fact that few patients connected MRI to cancer risk lends credence to the latter claim. Few patients were aware that air pollution (from naturally occurring background radiation) was linked to cancer.

This is relevant because the NHS explains the risk of ionizing radiation using background radiation [22]. It was a challenging question, and since responses tended to be near the right answer, indicated in gray in Table 1, it could be claimed that patients understood the risk sufficiently to recognize the risk–benefit balance, even though exact knowledge of absolute risk probability for the scenarios in Q7 was low (16%–26%). This trend aligns with previous studies on CT and X-ray that employed verbal risk descriptors (like low risk and high risk) that corresponded to the numerical risks utilized here (like 1/100 and 1/10)[15].

As with all other cases, computed tomography was an exception, with just 6% of respondents providing the right response. In addition, the top three responses did not contain the proper response. Actually, 88% underestimated CT risk, which is in line with earlier studies' findings of 85% [13]. Patients may underestimate their CT risk because they are unaware that a CT scan includes several X-rays for the reasons mentioned above. Understanding of Risk Comparisons: Comparing the Risk of Cancer from Arm X-Rays with Other Situations As was previously mentioned; understanding absolute risk may not be as crucial as being able to compare risks—that is, determine which risk is higher than another. Since it can be exceedingly challenging to convey uncertainty and individual probability, patients can better contextualize and comprehend risk by simply comparing risks. Allocated risks were compared in order to test this.

The absence of accurate risk assessments between imaging modalities is consistent with other studies that ask patients to compare risk directly [15, 16, and 23]. The 62% of situations when MRI was mistakenly greater or equal to X-ray risk undermines the earlier claim that MRI technology is safer due to its novelty. No study has evaluated the risk of MRI and X-rays. This disparity might indicate a lack of knowledge that must be addressed in conjunction with the relative danger of alternative imaging methods. This can be accomplished by use an X-ray as a risk denominator, such that one CT scan is equivalent to n X-rays. The X-ray risk comparison was far more accurate than the non-imaging risk comparison; this finding suggests that it may be more useful in discussions to offsetimaging risk against these better understood everyday risksthan referring to concepts like natural occurring radiation.

Attitude and Perception although most patients believed that X-rays were dangerous, this did not show up as a decision-limiting issue [24], with only three patients saying they had declined imaging. On the other hand, patients may expect imaging [16, 18] and underestimate the hazards [13, 16] involved. When asked if they had ever requested an X-ray but had not had one done, 22% of patients had expectations that were higher than those of clinically recommended imaging. This was less than anticipated, but it might have been because patients' expectations influenced their choices, which has been shown to increase the prescription of antibiotics in primary care [25]. The greater proportion of patients who want to have the last word when placing an X-ray order lends credence to this claim.

Patients may value quick diagnosis (via higher quality imaging) over long-term cancer risks (with lower radiation procedures), according to the final two questions, where nearly twice as many respondents agreed with Q16 [13, 15, and 24]. This propensity for short-term thinking could impede a healthy understanding of danger. Risk Factors Linked to Attitude, Perception, and Knowledge awareness of the dangers of radiation. Younger patients (less than 30) may have had higher understanding due to more modern school instruction that included CT and MRI (introduced in the 1980s); this is consistent with the strong favorable influence of schooling on radiation knowledge.

Both results are consistent with studies [15], which found comparable relationships between age and educational attainment. Research indicates that few people are informed about the hazards and advantages of CT scans [14], which may help to explain the detrimental impact of physicians on radiation knowledge. Additionally, physicians' own imaging expertise may be deficient [17]. The findings also indicated that 98% of participants reported experiencing discomfort, which may have been caused by a decline in cognitive function—a phenomenon that is especially associated with chronic paininterfering in some manner with learning or knowledge recall.

The majority of patients (83% n ¼ 219) rely on their doctors for health information, which is linked to a lower likelihood of seeing danger, making the doctor-patient connection crucial in forming patient perspectives. It is crucial to ensure that the permission procedure is based on confidence and reassurance rather than a lack of knowledge about the risks associated with imaging, as the association mentioned above may imply. In order to present a balanced view of risks and dangers, clinicians should be aware of the increased likelihood of danger perception with increased knowledge when educating patients. It appears that this balance is being struck because the perception of danger does not appear to translate into an association of knowledge with concern.

The correlation between Internet health information and concerns may indicate a growing dependence on the Internet for health information and self-diagnosis, as many people struggle to weed out irrelevant content. Clinicians should assent to opinions that are impacted, whether positively or negatively, by Internet searches because the Internet is the second-largest source of health information, behind doctors.

Conclusions:

Patients are unable to compare the danger of different imaging modalities and underestimate the risk of CT. Using more well-known, accessible threats as comparators helps communicate risk more effectively. Patient groups who are less knowledgeable and most in need of education are identified and it is shown how attitudes and perceptions can affect how risk is understood.

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