Patient Preference and Adherence

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ORIGINAL RESEARCH

Exploring Patient Preferences for Information About CT Radiation Exposure: Bridging the Gap Between Patient Preference and Physician Practice

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Background: CT scan utilizes ionizing radiation poses a danger to the patient's health. Thus, telling the patient about ionizing radiation would be critical in promoting shared decision-making and improving patient-doctor communication. However, few studies have examined this topic broadly.

Objective: The study was conducted to identify the frequency of physicians informing patients about the radiation risk before ordering a CT scan, as well as to examine the association between patients' demographic characteristics and their awareness of the radiation risks associated with CT scans.

Methods: A cross-sectional study was conducted among 387 patients who had undergone CT scans at a tertiary hospital in Riyadh, Saudi Arabia. Data were collected via phone interviews using a structured questionnaire. Chi-squared tests were employed to assess associations between patients' demographic characteristics and their awareness of CT scan radiation risks.

Results: When examining knowledge, 58% of patients knew that CT involves harmful radiation. This knowledge was significantly associated with higher education level and previous experience with CT scans. Regarding doctors' practice of providing information to patients about the scan, 344 (88.9%) patients indicated that their doctor had explained to them why they needed the scan. Only 28 (7.2%) patients stated that their doctor had mentioned the amount of radiation, and 74 (19.1%) patients indicated that doctors mentioned the risks associated with the radiation of the scan. Almost all patients (96.9%) preferred to be told about why they needed a CT scan.

Conclusion: The vast majority of patients who underwent CT scans did not receive enough information about the harm of the scans. However, most of them preferred to know about this harm.

Keywords: CT radiation exposure, patient preferences, informed consent, doctor-patient communication, radiation risks, cross-sectional study

Introduction

Computed tomography (CT) is an important radiological imaging technology and involves a series of radiographic projections that are combined to obtain computer-generated cross-sectional images. Since its invention in 1970, CT has worked wonders in the field of medicine by improving diagnoses, treatment therapies, and surgical procedures.[1] CT machines are widely available and offer accurate diagnosis to physicians in minutes. In addition, CT scans have reduced the number of emergency surgeries, ICU admissions, and length of hospital stay.[1,2]

Millions of CT scans are performed worldwide every year.[3] In just the USA and UK, more than 70 million and 5 million CT scans are performed every year, respectively.[4] Although CT scans have revolutionized the diagnostic department of medicine, they raise important public concerns about exposure to ionizing radiation, which could lead to harmful biological effects such as malignancy. It has been reported that a CT coronary angiogram exposes the breasts and lungs to radiation levels equivalent to 15 mammography studies and 711 X-rays of the chest, respectively.[5] CT scans

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deliver 50–1000 times more radiation to the human body than a conventional X-ray, contributing to about 50% of all medical radiation.[6] The utilization of CT scans is increasing day by day, exposing more and more people to the risk of ionizing radiation.

Growing concern about long-term outcomes of ionizing radiation, such as malignancy, warrants the application of fundamental protection rules in health care systems, such as justification, optimization, and dose limitation of radiological imaging techniques.[7] Justification of CT scans is of prime importance on the part of referring physician and radiologist as they must weigh the benefits of the imaging against the possible risks of radiation. In this context, CT scans can be replaced by non-radiating modalities, such as ultrasonography and magnetic resonance imaging (MRI) where possible. Similarly, optimization of CT scan guidelines and protocols could reduce unnecessary radiation exposure.

Recent studies, such as those conducted by Hyde et al in Australia, have highlighted significant gaps in the provision of preparatory information to patients undergoing medical imaging procedures.[8] These studies found that a substantial proportion of patients reported not receiving important information before their procedures, which could contribute to increased anxiety and dissatisfaction with care. Specifically, Hyde et al reported that many patients did not receive guideline-recommended information about managing anxiety during and after the scan, the risks associated with the procedure, and other critical aspects of their care.[9]

While these findings are important, it is essential to consider the context in which they were obtained. Cultural, structural, and regulatory differences between healthcare systems can significantly influence the generalizability of these findings to other settings, such as Saudi Arabia. For instance, in Saudi Arabia, the healthcare system is characterized by a unique blend of public and private providers, with varying levels of patient engagement and communication practices. Cultural factors, such as patients' expectations of physician authority and the level of deference to medical professionals, may also impact the extent to which patients expect or demand detailed information about medical procedures.

In this regard, referring physicians and radiologists must have proper understanding of CT and accurate estimation of the amount of radiation being delivered to patients. A survey evaluated the attitudes of radiologists towards radiation dose and exposure in Saudi Arabia and reported that radiologists have good comprehension of the carcinogenicity risk for patients undergoing CT scans.[7] The fundamental principles of radiation protection are even more important when dealing with pediatric populations, as children are more sensitive to radiation than adults.[10]

CT poses a significant long-term risk of cancer due to radiation exposure. To respect the dignity and autonomy of the patients, obtaining informed consent for radiological examinations is their ethical and legal right.[11] Therefore, prior to advising and embarking on CT imaging, physicians and radiologists should obtain informed consent after clearly explaining the hazards of the radiation exposure. This practice could help with shared decision making between physicians and patients. In this context, one of the fundamental principles of modern medicine is to make informed decisions about the patients' treatment.[11] The purpose of obtaining informed consent is to ensure that the patients fully understand the procedure while avoiding underestimation and overestimation of the hazards of large and small risks of the radiation that patients might absorb during the procedure.

CT scan with intravenous contrast infusion may result in extra hazards, such as contrast-related hypersensitivity and contrast-induced nephropathy, in addition to the radiation-related risks.[11] In this regard, patients must be informed about these contrast-induced complications via informed consent forms. Moreover, some patients may have a history of previous CT imaging, and CT imaging poses further radiation-related hazards that should be communicated to the patients.

The statements offered in the informed consent forms may vary. Recent consent forms follow one of three philosophies: "do not say a word", "understatement", and "full disclosure".[11,12] "Do not say a word" refers to not mentioning the hazard of radiation, and the legal right of informed consent is eclipsed by the patients' perception that the experts are efficient and know best. "Understatement" is based on imprecise statements to avoid "useless" concern about risk that is unavoidable. The third philosophy of "full disclosure" uses straightforward statements in providing informed consent, especially when it comes to the research projects.

Only preliminary studies are available from Saudi Arabia about the knowledge, perceptions, and preferences of patients undergoing CT imaging. In addition, studies that examined this topic broadly to determine the gap in patient-doctor communication are lacking in Saudi Arabia. Therefore, this study was conducted to assess these issues. This study could be a useful addition to the literature from Saudi Arabia about these patient characteristics and clinician practice.

Methods

Study Design and Setting

This cross-sectional study involved patients undergoing CT scans. The study was conducted in the outpatient department at a tertiary hospital in Riyadh. The study was approved by the Institutional Review Board of the College of Medicine of King Saud University (No. E-19-3904). The study was conducted using phone call interviews. Verbal consent was obtained from participants before they answered the questionnaire, and their identity was kept confidential. To minimize bias, the interviews were conducted using a standardized script, and all researchers involved in data collection were trained to follow the same protocol. Additionally, the questionnaire was reviewed by expert radiologists and family physicians to ensure its relevance and clarity. The internal consistency of the questionnaire was measured using Cronbach's alpha, which exceeded 0.7, indicating good reliability.

Participants and Survey Instrument

Participants included patients who underwent a CT scan within three months at a tertiary hospital in Riyadh at the outpatient radiology department. Data were collected between September 2020 and January 2021 by simple random sampling. A list of patients who underwent CT was obtained, and we selected every other patient. Using phone interviews, the researchers asked all the questions in the questionnaire.

We created the questionnaire after an extensive literature review.[13,14] The questionnaire was then reviewed by two expert radiologists and family physicians who have the expertise in this area. Afterwards, the suggested adjustments were made, and a final draft was set after a pilot study. The pilot study took place with 20 patients to ensure that the questions were clear, understandable, and in a logical order. Those who participated in the pilot study were not enrolled in the final analysis. The internal consistency (reliability) was measured using Cronbach's alpha coefficient, which was >0.7.

The questionnaire was divided into four sections. The first section describes socio-demographics, the second assesses the encounter between the patient and the physician before ordering the CT scan, and the third section focuses on the participants. The final part measured knowledge regarding radiation, patient perceptions, and the amount of information that participants wanted regarding radiation (Supplementary File 1).

The data collection was carried out meticulously by the two authors, who ensured consistency and accuracy throughout the process. Both authors conducted the phone interviews, adhering to a standardized script to minimize interviewer bias. The questionnaire was administered in a consistent order for all participants, and responses were recorded verbatim. To ensure accuracy in data entry, each author independently entered the data, and any discrepancies were resolved collaboratively by cross-referencing the original interview recordings. Any missing or incomplete responses were systematically addressed using appropriate statistical methods, such as imputation or exclusion, depending on the nature and extent of the missing data.

Sample Size

We estimated that for a precision of 5% with 95% confidence intervals, at least 323 people would be required to estimate the proportion of individuals who know that imaging tests incur a health risk. Based on a literature review, around 70% of the population could be aware of it. Next, 20% was added, so our sample size was 388 patients.

Eligibility Criteria

Participants were eligible for inclusion in the study if they were 18 years or older, had undergone a CT scan within the last three months at the participating hospital, were able to provide informed consent, and were sufficiently literate to understand and respond to the questionnaire administered during phone interviews. Patients who were unable to participate in the phone interview due to language barriers, cognitive impairments, or severe illness were excluded from the study.

Participant Recruitment

Potential participants were identified from a list of patients who had undergone a CT scan during the study period. Every other patient on the list was randomly selected for potential inclusion in the study. Selected patients were contacted by

phone by the two authors of the study, who provided information about the study's objectives and procedures. Verbal informed consent was obtained from all participants before the interview, and participants were assured of the confidentiality of their responses.

Ethical Statement

The study was reviewed and approved by the Institutional Review Board (IRB) of King Saud University, College of Medicine, King Saud University Medical City (Approval Research Project No. E-19-3904, May 05, 2020). Informed consent was obtained from all participants involved in the study. The process was conducted following the ethical guidelines outlined in the Declaration of Helsinki. The research was carried out in accordance with the rules and regulations of the Kingdom of Saudi Arabia and the research policies and procedures of the King Saud University IRB.

Statistical Tests

Data were entered and analyzed using IBM SPSS Statistics for Windows, Version 24.0 (Armonk, NY: IBM Corp). Categorical data are presented as numbers and percentages. The chi-squared test was used to assess the association between awareness about the CT risk and patients' baseline characteristics. The level of significance was set at $\alpha = 0.05$.

Results

A total of 500 individuals who had undergone a CT scan within the last three months were initially identified and assessed for eligibility. Of these, 450 were confirmed to be eligible based on the inclusion criteria (age, literacy level, and ability to provide informed consent). The primary reasons for ineligibility among the 50 excluded individuals were language barriers (n = 20), cognitive impairments (n = 15), and severe illness (n = 15). Out of the 450 eligible individuals, 387 consented to participate in the study, resulting in a consent rate of 86%. The reasons for non-participation among the eligible individuals (n = 63) included refusal to participate due to lack of interest (n = 40) and concerns about the confidentiality of responses (n = 23).

The study included 387 patients who underwent CT scan, and 203 (52.5%) patients were males. A majority of the patients (190 patients; 49.1%) belonged to the age group of 40 to 60 years old. More than half of the patients (200 patients; 51.7%) were university graduates. Internal medicine and urology were the most common referral specialties for the CT scan at 21.2% and 20.2%, respectively. Around one-quarter of the patients (25.1%) had never had a CT scan before, and 118 (30.5%) had at least four CT scans before (Table 1).

Out of the 387 participants, 344 (88.9%) reported that their doctor explained why the CT scan was necessary. However, only 28 participants (7.2%) stated that their doctor discussed the radiation dose involved in the scan, and 74

Table 1 Patients' Baseline Characteristics

		N	%
Age (years)	18–24	33	8.5
	25–39	148	38.2
	40–60	190	49.1
	60 or more	16	4.1
Gender	Male	203	52.5
	Female	184	47.5
Education level	Less than high school	77	19.9
	High school	110	28.4
	University/College	200	51.7

(*Continued*)

Table 1 (Continued).

		N	%
Which specialty is following up with you?	Oncology	44	11.4
	General Surgery	59	15.2
	Internal Medicine	82	21.2
	Orthopedics	44	11.4
	Family Medicine	22	5.7
	Urology	78	20.2
	ENT	21	5.4
	Others	37	9.6
How many times have you undergone a CT scan previously?	Never	97	25.1
	Once	72	18.6
	Twice	64	16.5
	Three times	36	9.3
	More than three times	118	30.5

participants (19.1%) indicated that their doctor mentioned the risks associated with the radiation exposure. Almost all participants (96.9%) expressed a preference to be informed about the need for the CT scan, 94.3% expected to be informed about the associated risks, and 78.6% preferred to know the radiation dose (Tables 2 and 3).

In terms of patients' baseline characteristics, the patients with higher education level and previous experience with a CT scan had significantly higher knowledge about CT scans and their hazards. As the education level increased, the

Table 2 Doctor's Practice Toward Information Provided to Patients About the Scan

Practice	Yes		No	
	N	%	N	%
Has your doctor explained to you why you need this scan?	344	88.9	43	11.1
Has your doctor mentioned to you the amount of radiation associated with this scan?	28	7.2	359	92.8
Has your doctor mentioned to you the risks associated with the radiation expected from this examination?	74	19.1	313	80.9

Table 3 Patients' Perceptions, Beliefs, and Preferences

Variable	Category	N	%
The effect of the information you receive	I do not trust it	2	0.5
	It has no special effect on me	56	14.5
	It reassures me	45	11.6
	Not explained	284	73.4
Do you think you should be told about why you need a CT scan?	Yes	375	96.9
	No	12	3.1
Do you expect to be told about the associated risks?	Yes	365	94.3
	No	22	5.7
Do you think you should be told about the radiation dose?	Yes	304	78.6
	No	83	21.4

Table 4 Association Between Patients' Baseline Characteristics and CT Scan Radiation Risk Awareness

Variable	Category	Awareness of Computed Tomography Radiation Risk				χ^2	P-value
		Yes		No			
		N	%	N	%		
Age (years)	18–24	18	54.5	15	45.5	3.674	0.293
	25–39	94	63.5	54	36.5		
	40–60	106	55.8	84	44.2		
	60 or more	7	43.8	9	56.3		
Gender	Male	115	56.7	88	43.3	0.393	0.533
	Female	110	59.8	74	40.2		
Education level	Less than high school	37	48.1	40	51.9	8.406	0.015*
	High school	58	52.7	52	47.3		
	University/College	130	65.0	70	35.0		
Which specialty is following up with you?	Oncology	28	63.6	16	36.4	5.282	0.685
	General Surgery	33	55.9	26	44.1		
	Internal Medicine	46	56.1	36	43.9		
	Orthopedics	25	56.8	19	43.2		
	Family Medicine	10	45.5	12	54.5		
	Urology	51	65.4	27	34.6		
	ENT	13	61.9	8	38.1		
	Others	19	51.4	18	48.6		
How many times have you undergone CT scan previously?	Never	45	46.4	52	53.6	10.645	0.032*
	Once	43	59.7	29	40.3		
	Twice	35	54.7	29	45.3		
	Three times	22	61.1	14	38.9		
	More than three times	80	67.8	38	32.2		

Notes: P-values were calculated using the chi-squared test. *Indicated significant associations.

knowledge of CT increased (p-value = 0.015). Similarly, the number of previous scans was associated with higher knowledge of the potential risks of CT (p-value = 0.032; Table 4). Furthermore, 58% of patients knew that CT involves harmful radiation, and only 27% knew that mammograms involve harmful radiation. However, only 20% of patients knew that MRIs do not involve harmful radiation (Figure 1).

Discussion

This study was conducted to assess the knowledge, perceptions, and preferences of Saudi patients in Riyadh undergoing CT scans in regard to the risk of radiation they may receive during the procedure. The results show a significant association of education level and previous experience with CT scan knowledge. Most of the patients were referred from the departments of internal medicine and urology. Also, most of the patients perceived that they should be told and

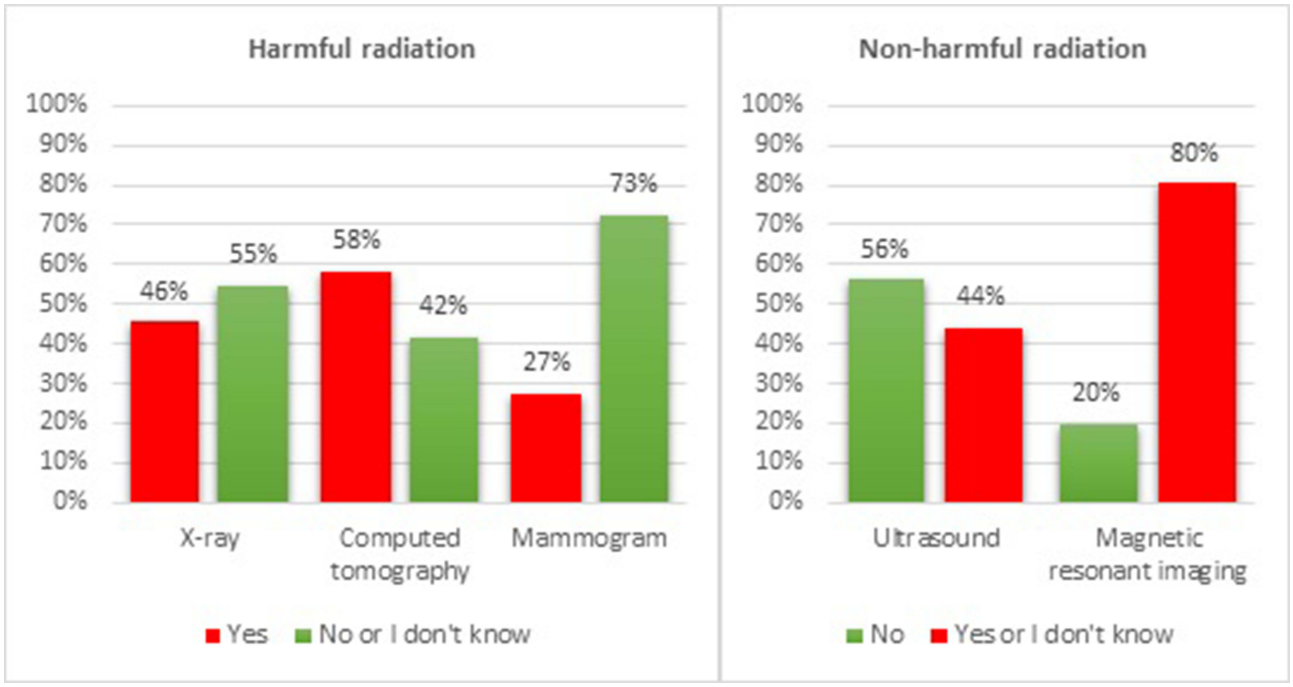

Figure 1 Patients' knowledge about harmful radiations. The figure on the left "red" bars represents the percentage correct answer of harmful radiation (Yes). The figure on the right "green" bars represents the percentage correct answer of non-harmful radiation (No).

preferred to be told about why they needed a CT scan, the radiation dose, and the risk. Furthermore, most of the patients received an explanation about why they needed to undergo a CT scan. However, the vast majority of patients were not told about the amount of radiation and its risks.

CT is a distinct source of radiation exposure. Ionizing radiation is a known carcinogen, and the amount of radiation delivered by CT imaging varies across patients, institutions, and regions.[15] The risk of cancer depends on several factors, such as the part of the body exposed, age of the patient, gender, and dose of radiation delivered to the patient's tissues.[16] A single CT scan of the abdomen may expose the patient to 10 millisieverts (mSv) of radiation.[17]

Radiation-induced risk at doses of 10–100 mSv is controversial and falls in the range of medical imaging, especially CT imaging.[15] However, patients who undergo multiple CT scans or multiphasic CT are at increased risk of cancer.[17] Interestingly, the medical imaging delivers a dose of radiation of 10 mSv or less, and no direct evidence is available in terms of increased risk of cancer.[17] However, it does not reflect that there is no radiation-related risk with CT imaging.

Overall, studies have reported limited or lacking knowledge about ionizing radiation among patients undergoing radiological procedures.[18] This is in line with our result, where only 58% of participants correctly believed that CT scans are harmful, while 80% wrongly believed that MRI is harmful. According to the World Health Organization (WHO), the major barriers in effective communication include insufficient knowledge of physicians, radiographers, and nuclear medicine technologists about radiation exposure, as well as underestimation of the radiation dose and its risks.[19]

Al-Mallah et al conducted a cross-sectional study with 416 Bahraini patients attending the radiology department to evaluate the patients' awareness and knowledge about the associated risks of ionizing radiation.[20] They compared the radiation-related knowledge between prescribed and self-presenting patients and reported no significant effect of age, gender, or education level on the awareness and knowledge about the risk of ionizing radiation. However, they reported more knowledge about ionizing radiation among prescribed patients than among self-reporting patients in terms of minimization and prevention of radiation exposure, lifelong health concern, and belief of better diagnosis with radiological procedures. This difference may be attributed to the information offered in the informed consent procedure provided by the clinician prior to the radiological

procedure. Another possible reason is direct conversation between the patient and the clinician about the need for a CT scan and its radiation hazards during a visit.[20]

Usually, patients underestimate the radiation risk that they undergo and cannot compare radiation exposure between radiological modalities.[21] Therefore, they must be told about the radiation dose that they are to receive and its risks. This would allow them to share in making decisions with the clinician, and patient autonomy is one of the fundamental principles of medical ethics. In the present study, the majority of patients reported that they were not told about the radiation risk (19.1%) and its dose (7.2%). Nevertheless, most of the participants preferred to know this information (94.3% and 78.6%, respectively).

To our knowledge, this study is the first study to report what doctors tell their patients about the radiation risk and to what extent patients prefer to know about it in Saudi Arabia. Therefore, we cannot compare these results with other local data. However, the results of a recent survey in Spain are comparable to our findings as they showed that less than 20% of participants indicated that they were told about the risk of radiation from imaging.[13] In addition, another study showed that 95.9% of patients expected to be told about the risk of the radiation, and 94.6% expected to be told about the dose.[14] Moreover, a study conducted in an emergency department indicates that nearly all of participants were not told about the radiation dose and the risk.[22] This could be explained by the nature of the patients' illnesses and the pain associated with them in the emergency department in comparison to outpatient settings.

Obviously, the responsibility at the end is the clinicians', who must inform patients and mention the hazards of CT scan radiation. This issue might have arisen due to two of the philosophies mentioned above—ie, "do not say a word" and "understatement", where patients' rights to know are eclipsed by a paternalistic vision and unavoidable risk.[23] Above all, it is a legal and ethical right of the patients to know about the procedure and its risks. In this regard, the present study has reported that those who had previous experience with CT scans had improved knowledge about CT imaging.

Medical professionals are the main source of radiation-related information. Therefore, physicians and radiologists must have up-to-date knowledge about CT scan radiation and its hazards. Unfortunately, medical professionals lack knowledge about radiation doses and their risks, and they underestimate the radiation dose being delivered to the patients.[19] In this context, courses could be arranged to refresh the knowledge of medical professionals about radiation hazards and protection.[24]

The present study has practical value as it offers a comprehensive approach to the perceptions and preferences of patients about CT scans and their radiation hazards. It also points out that most of the patients are not told about the radiation dose and its long-term hazards, thus warranting more precise and comprehensive sessions between patients and clinicians before embarking on radiological procedures. This would help to promote shared decisions and patient-centered care.

This study has several limitations that should be acknowledged. First, the data collection relied on a study-specific tool developed by the authors. While the questionnaire was carefully constructed based on an extensive literature review and refined through a pilot study, it has not been validated in other settings or populations. This could introduce some bias or limit the generalizability of the findings, as the accuracy of the data might be affected by the specificity of the tool used.

Second, the mode of data collection involved structured phone interviews. While this method allowed for the efficient collection of data and ensured that participants could seek clarification on any questions, it may have also introduced certain biases. For instance, participants might have provided socially desirable responses or may have felt pressured to respond in a certain way due to the presence of an interviewer. Additionally, the lack of visual cues and face-to-face interaction could have impacted the depth and accuracy of responses.

These limitations suggest that while the study provides valuable insights into patient knowledge, perceptions, and preferences regarding CT scan radiation risks, caution should be exercised when interpreting the findings. Future research might consider using a validated survey instrument and exploring alternative modes of data collection, such as self-administered questionnaires, to address these potential sources of bias.

Conclusion

Despite the majority of patients preferring to know about the harm of CT scan radiation, most of them did not receive enough information from their clinicians about it. The education level of patients and previous experience with CT scans were significantly associated with better patient knowledge about CT imaging and its radiation hazards. Offering patient-centered care and sharing decisions between the patient and the clinician after discussing the benefits and risks of CT scans will help to meet the patients' expectations and preferences, as well as to fill the gap in doctor-patient communication.

Disclosure

The authors declare no conflict of interest.

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