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Knowledge and Awareness of Sudanese and Chinese Dentists towards Cone-Beam Computed Tomography (CBCT)

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ABSTRACT

Aim: *The study aimed to assess and compare the knowledge and awareness of Sudanese and Chinese general dental practitioners and orthodontists regarding Cone-Beam Computed Tomography (CBCT).*

Subject and method: *A total of 294 participants were enrolled, predominantly consisting of Dentist under 30 years old, with a majority being female (73.8%). Around half of the participants were Sudanese (52.4%), and the rest were Chinese (47.6%). The majority were general practitioners (74.8%), with the remaining 25.2% being orthodontists. It was conducted as a descriptive cross-sectional hospital-based study, utilizing a questionnaire to collect data on participants' knowledge and awareness of CBCT.*

Results: *The study found that more than 200 participants had poor knowledge of CBCT, defined as scoring less than 50% on knowledge questions. Notably, 80% of Chinese participants and 69.5% of Sudanese participants had poor knowledge, indicating a significant association between nationality and knowledge level ($p < 0.05$).*

Conclusion: *CBCT represents an advanced imaging technique with considerable potential in dentistry, a fact increasingly recognized by dental specialists. However, the study revealed a significant gap in knowledge and awareness of CBCT applications among participants, with a particular emphasis on the need for training in this field. Nationality and job position were also found to be significantly associated with knowledge levels, underscoring the importance of addressing these disparities in future education and training initiatives.*

Keywords

CBCT, Knowledge, Awareness, Orthodontist, General practitioner.

Introduction and Review of Literature

Radiology stands as a crucial discipline for accurately diagnosing dental and maxillofacial disorders in patients. While conventional methods like ordinary x-ray transmission and panoramic radiography have been useful in various clinical scenarios, the utilization of multiplanar imaging, including computed tomography (CT), can occasionally enhance radiographic assessments [1].

The advent of cone-beam computed tomography (CBCT) represents a significant advancement, offering three-dimensional visualization of the maxillofacial skeleton with high diagnostic precision for hard tissues [2]. Notably, CBCT minimizes distortion and radiation dosage compared to conventional CT scans, providing volumetric data instead of slices [3].

However, the adoption of sophisticated imaging techniques like CBCT is often hindered by cost, availability, and radiation dosage concerns [4]. Despite these limitations, CBCT's introduction for craniofacial imaging enables dental practitioners to access advanced diagnostic tools, aiding in precise diagnosis and treatment planning [4]. CBCT boasts several advantages, including its suitability for imaging the maxilla or mandible individually or both jaws simultaneously, producing clear images with high

contrast crucial for bone evaluation [5,6]. Additionally, CBCT offers decreased X-ray beam exposure and customizable radiation dosages for specialized diagnostic activities, surpassing traditional CT scans in image accuracy and scan duration while reducing effective radiation dosage [6]. Although CBCT is a valuable tool in clinical dentistry, its adoption may be influenced by factors like cost and space limitations, with scanning typically confined to the head [5,6]. Nonetheless, CBCT finds wide-ranging applications, including orthodontic treatments, temporomandibular joint (TMJ) inspections, and evaluation of pathologic lesions, tumors, and cysts [7].

The European Academy of Dental and Maxillofacial Radiology has released recommendations for its use in European nations [8]. However, such a policy does not exist in various other nations. A literature review underscores the pivotal role of oral radiography in dental diagnosis and therapy, emphasizing the imperative of minimizing radiation exposure, especially in three-dimensional (3D) imaging of the head and neck region [9]. Dawood et al. highlight cone-beam computed tomography (CBCT) as a relatively new technique in dentistry, facilitating 3D imaging of the dentition and jaw. While CBCT exposes patients to significantly less radiation than typical CT scanners, it surpasses traditional 2D dental imaging in radiation dose. The paper stresses the importance of comprehensive training for all members of the treatment team involved in CBCT radiography and radiology [10].

A survey by Ghoncheh et al. among Iranian dentistry graduates revealed insights into CBCT usage and attitudes. While nearly half of the respondents utilized CBCT, barriers to its prescription included additional expense, concerns about patient radiation exposure, limited availability of CBCT facilities, and prolonged procedure duration. Nonetheless, CBCT was recognized as an exceptional imaging technology in dental practice, with recommendations for dentists to undergo workshops to enhance proficiency [11].

Amita et al. conducted a systematic questionnaire-based survey among various dental professionals, including teaching faculty, private practitioners, and postgraduate students, focusing on their understanding, attitude, and perspective regarding CBCT utilization in dentistry. The findings showcased varying levels of CBCT recommendation among participants, with a significant portion advocating its use for implant planning and assessing surgical site proximity to vital structures. The study concluded that there is a significant disparity in the understanding of CBCT applications among dental specialists, highlighting a perceived low level of awareness and training in this area among dental professionals. The researchers strongly advocate for the incorporation of CBCT training at both the undergraduate and postgraduate levels to address these knowledge gaps and ensure proficiency in utilizing this valuable imaging technology [12].

Bhagat et al. conducted a study in Nanded, Maharashtra, India, involving 150 participants, including both graduates and postgraduates, with a mix of genders. Their self-administered questionnaire, comprising 25 questions, highlighted a significant lack of knowledge and comprehension among dental practitioners regarding CBCT and its applications. The study underscored the urgent need for training in CBCT, particularly through workshops, and recommended integrating CBCT training into the final year of Bachelor of Dental Surgery (B.D.S.) programs [13]. Similarly, Kamburolu et al. assessed the knowledge and attitudes of Turkish dental students toward CBCT through a questionnaire distributed to 472 participants from two Ankara colleges. The study revealed that only a fraction of students had heard of CBCT, with the majority learning about it through classroom instruction. The findings emphasized the necessity of incorporating CBCT education into dental school curricula, with a high percentage of students expressing a desire to use CBCT in their future careers [14]. Moreover, research from Turkey and Norway highlighted the prevalent use of CBCT for implant placement [15].

Thakkar et al. aimed to evaluate the knowledge, attitude, and practice of general dentists toward CBCT and dental radiology. Their questionnaire survey, conducted among 250 dental practitioners in Central India, revealed that a significant proportion of practitioners had recommended CBCT scan to their patients. Additionally, the majority expressed satisfaction with CBCT usage and believed it should be employed for specific dental applications. The study emphasized the importance of regular training and workshops in enhancing CBCT proficiency among dental practitioners [16]. The researchers noted an increased awareness of CBCT among dental professionals and highlighted the widespread belief that CBCT is an indispensable diagnostic tool in dentistry and research.

Qirresh et al. conducted a study in 2016 to assess the knowledge, attitude, and awareness of Palestinian dentists regarding the use of cone-beam computed tomography (CBCT). The research utilized an online questionnaire distributed to 300 private dental practitioners who were members of the Palestinian Dental Association. Among the respondents, 176 dentists provided responses, while 110 did not respond, and contact could not be established with 14 dentists. All respondents indicated familiarity with CBCT and expressed the opinion that its utilization in dental radiography should be expanded. They also recommended organizing more workshops to enhance understanding of CBCT. Despite the widespread acceptance of CBCT among dental specialists, the study's findings revealed a significant gap in dental professionals' knowledge of its applications [17].

Shivanshu et al. conducted a cross-sectional study among 200 private dental practitioners in Ghaziabad District, India, aimed at assessing their knowledge and understanding of Cone Beam Computed Tomography (CBCT). Results showed that 75% of practitioners held only undergraduate degrees, while 40 practitioners had both undergraduate and postgraduate degrees. Moreover, only 6 practitioners had been practicing for more than 15 years. Alarmingly, 54 practitioners were unaware of the usage of CBCT, and 188 mentioned that the undergraduate

dental curriculum was inadequate regarding CBCT. The authors concluded that the knowledge and understanding of CBCT among dentists was below moderate and emphasized the need for educational programs and method demonstrations [18].

Tofangchiha et al. conducted a descriptive cross-sectional research study in Qazvin with 100 Iranian dentists, both general practitioners and specialists, using a questionnaire to gather information on CBCT. The data revealed varying levels of knowledge among dentists, with 4% having a very low level, 16% having a low level, 50% having a moderate level, 19% having a high level, and 11% having a very high level of knowledge. The authors concluded that dentists had an average level of CBCT knowledge and recommended certification workshops to enhance their expertise (19).

In 2018, Parveen et al. conducted research to evaluate the applicability of moral principles in prescribing CBCT scans and assess the understanding of CBCT recommendations in the orthodontics sector. One hundred and one orthodontists and one hundred and two orthodontic residents participated in the study. The findings indicated that only 101 participants were aware of the CBCT recommendations in orthodontics. The study shed light on the ethics and principles that should be followed when using CBCT scans in orthodontics [20].

Reham et al. conducted an observational cross-sectional online survey among 108 female undergraduate and postgraduate Saudi dentistry students at Taibah University's College of Dentistry. The study aimed to analyze the knowledge and attitude toward CBCT. Results showed that both undergraduates (78.6%) and postgraduates (90.9%) were pleased with the usage of CBCT. The authors recommended incorporating sufficient CBCT practical training into dentistry school curricula to enhance students' fundamental knowledge and interpretation of this new method 21).

Smith et al. conducted a study to evaluate the use of cone-beam computed tomography (CBCT) in graduate orthodontic residency training in America and Canada. They distributed an email questionnaire to the program coordinators of sixty-nine graduate orthodontic programs in America and Canada, with 36 programs (52.2%) responding. The findings revealed that 83.3% of respondents had access to CBCT scans, and 73.3% used it routinely, primarily for precise diagnostic purposes. Didactic and practical training on CBCT was received by 59.1% of respondents, while 31.8% received only didactic training. CBCT was predominantly used for diagnosing impacted/supernumerary teeth, craniofacial deformities, and temporomandibular joint (TMJ) disorders [22].

Yeung et al. investigated the awareness and use of 2D and 3D diagnostic imaging among licensed dentists in Hong Kong using an online questionnaire. They found that male dentists and those with higher education levels were more confident in taking and interpreting CBCT images. Dentists with more experience felt more comfortable interpreting CBCT images. The researchers recommended ongoing professional education emphasizing the significance of digital imaging and providing training in CBCT modality, radiation dosage, and image interpretation [23].

Patel et al. conducted a study in Baroda to examine the awareness, knowledge, and attitudes of dental practitioners regarding cone beam computed tomography (CBCT). They distributed a questionnaire via Google form to 200 dental practitioners, with 164 questionnaires analyzed. The majority of dentists used digital radiographs, but some cited the expensive cost as a reason for not using it. Most dentists had attended courses related to CBCT and believed in its usefulness for diagnosis and treatment planning [24].

Ramachandran and Hegde surveyed 250 dental practitioners to measure their understanding of CBCT application. They found that most responders were uncertain about the radiation dose of CBCT compared to other imaging modalities but were willing to use it. The authors suggested increasing educational programs and knowledge dissemination about CBCT to enhance oral health care practice [25].

Scarfe et al. reported on the advantages of CBCT, highlighting its ability to provide high-quality three-dimensional representations of the maxillofacial skeleton with minimal image distortion and lower radiation dosage than conventional CT scans. CBCT offers submillimeter spatial resolution and quick scan times, making it a valuable diagnostic tool for dental professionals [26].

A cross-sectional study in three Middle Eastern countries assessed dentists' knowledge and perspectives toward CBCT. It found that educational status and practice location significantly influenced CBCT knowledge, while age, gender, and years of work had no impact [27]. However, nationwide investigations in India revealed varying levels of awareness about CBCT among orthodontists and orthodontic postgraduate candidates [28,29]. Similarly, studies in Sudan and Khartoum Teaching Dental Hospital found disparities in CBCT knowledge among dentists, with a significant proportion lacking adequate information due to insufficient undergraduate curriculum coverage [29,30].

In Turkey, orthodontists primarily utilized CBCT for detecting impacted teeth and other oral abnormalities, with seminars being the main source of CBCT education [31]. Additionally, a study in India found that dental postgraduate candidates had limited awareness of CBCT terminologies and expressed concerns about its radiation dose compared to other radiographic imaging [32].

In 2015, a survey of 200 dentists aimed to assess their attitudes and knowledge of cone beam computed tomography (CBCT). The majority of participants were already aware of CBCT, with 27% believing it would become the ideal tool in future dentistry and investigations, while 73% disagreed [33].

In India, a study conducted by Keerththana Balabaskaran et al. in 2013 assessed the awareness and attitude of dental professionals

toward CBCT. They utilized a multiple-choice questionnaire and found that 82% of participants were aware of CBCT's use in the dentomaxillofacial region, while 18% were not. Among those aware, 48% learned about CBCT through lectures and classes, 12% from the internet, and various other sources. However, only 39% of the aware participants attended CBCT workshops [34].

Another study conducted in India by Rai S aimed to examine dentists' precise understanding of dental radiology and CBCT. Using a questionnaire filled out by 500 participants, Rai found that different types of dental specialists exhibited varying levels of understanding of CBCT applications [35].

Problem Statement

Despite the availability of screening tools, the utilization of Cone Beam Computed Tomography (CBCT) in dental clinics in Sudan and China is poorly documented. This could be attributed to the average level of knowledge about CBCT among dental professionals and the lack of qualification programs aimed at enhancing their awareness about computed tomography.

Justification

Despite the increasing availability of training opportunities in the dental field in Sudan and China, the knowledge of dental professionals regarding the care of patients who require CBCT appears to be highly variable, particularly among some dental practitioners. To the best of our knowledge, no similar study involving this research has been carried out in China, while only one study has been conducted in Sudan. Therefore, there is a need for further investigation to understand the level of knowledge and awareness among dental practitioners regarding the usage of CBCT.

General Objective

To study the level of knowledge and awareness of Chinese and Sudanese orthodontists and general dental practitioners towards CBCT.

Specific Objectives

To assess the understanding of CBCT among orthodontists and general dental practitioners in Chinese and Sudanese.
To determine the level of awareness of CBCT among Chinese and Sudanese orthodontists and general dental practitioners.

To compare the results obtained between Sudanese and Chinese orthodontists and general dental practitioners, as well as with previous studies conducted in different populations.

Subjects and Methods

This study utilized a descriptive cross-sectional design and was conducted in Khartoum, Sudan, and Xian, China, spanning from May 2021 to February 2022. The study population consisted of orthodontists and general dental practitioners enrolled in Sudan and China.

Inclusion criteria for Sudanese participants encompassed Sudanese nationality, being a general dental practitioner or orthodontist, and being aged between 25 and 45 years old. On the other hand, non-Sudanese practitioner were excluded.

Similarly, inclusion criteria for Chinese participants included Chinese nationality, being a general dental practitioner or orthodontist, and being aged between 25 and 45 years old, while Non-Chinese Nationality were excluded.

The sample size for this study was estimated according to the following equation from (https://www.openepi.com/Sample Size
Sample size n = [DEFF*Np(1-p)]/ [(d2/Z21-α/2*(N-1) +p*(1-p)]
Where n: required sample size N: population size p: Hypothesized % frequency of outcome factor in the population D: is margin of error at 5 % Z: confidence level 90% N: Is population size
When applying the above equation, the sample size was estimated to be 271. The sample was selected conveniently, including all participants who responded to the questionnaire.

Research Tools and Data Collection Methods

Data collection involved using a structured questionnaire designed specifically for general practitioners and orthodontists in Sudan and China. The questionnaire was distributed through various online platforms. The questionnaire comprised 24 questions covering demographic details of the participants (without identifying information), referral frequency, training in CBCT, general awareness towards CBCT, and questions aimed at assessing knowledge level and usage of CBCT.

The validity of the questionnaire was ensured through validation by two specialist dentists. They reviewed the questions in relation to the research objectives and also edited the paper for spelling and grammatical accuracy.

Data Analysis

Descriptive statistics were used to provide frequency distributions in connection to demographic data and responses to questionnaire items. This allowed for a comprehensive understanding of the participants' characteristics and their responses to CBCT-related questions.

Analytical Statistics

Correlation between dependent variables (knowledge and awareness) and independent variables (gender, age groups, nationality, specialty, and years of experience) was assessed. Knowledge and awareness scores were calculated based on the percentage of correct answers. Scores were categorized into poor, moderate, and excellent based on specific thresholds. The ***chi-square*** test was utilized for association analysis. Results were presented using tables, histograms charts.

Statistical analysis was performed using SPSS version 25. Both descriptive and analytical statistics were employed in the analysis. A significance level of 0.05 was used.

Ethical Clearance

Approval for the study was obtained from the Department of Orthodontics at Xi'an Jiaotong University's Stomatology Hospital. Final permission was granted by the research committee at the same institution. Informed consent was obtained from all participants prior to their participation in the study.

Results

The study encompassed a cohort of 294 participants who responded to and enrolled in the research. The distribution of ages among Sudanese and Chinese general practitioners and orthodontists revealed that the majority, comprising 202 individuals (66.7%), were aged less than 30 years, while 82 participants (27.9%) fell within the 30 to 40 years of age. Only 10 participants (5.4%) were over 40 years old.

Regarding gender distribution, females constituted the predominant group, making up 74% of the participants, whereas males accounted for 26%.

In terms of nationality, 52% of the participants were Chinese, and the remaining 48% were Sudanese. Furthermore, 75% of the participants held positions as general practitioners, with the remaining 25% being orthodontists. Examining the cumulative number of patients treated by Chinese and Sudanese orthodontists, it was found that 50 orthodontists treated fewer than 100 patients, 18 treated more than 100 but less than 500 patients, and only four treated more than 1000 patients. In regard to professional experience, 166 participants had less than 2 years of experience, 69 had between 2 to 5 years, 25 had 5 to 10 years, and a mere 24 had over 10 years of experience.

CBCT courses and referral

The result in Table 1 illustrates that among the participants, the majority reported occasionally referring patients to CBCT imaging (37.4%). About 34.2% of the participants encountered CBCT through undergraduate lectures. Interestingly, 77.2% and 76.2% stated that they did not receive any training in CBCT during their undergraduate and postgraduate education, respectively. Additionally, 78.9% of the total sample did not attend any course related to CBCT, while 21.1% reported attending such courses.

Table 2 illustrates that the majority of participants believe that CBCT offers advantages, with 42.5% stating that the three-dimensional structure is more helpful for the clinical judgment of orthodontists. Additionally, 59.2% think that root resorption is better visualized in CBCT scans, while 38.8% reported that airway space is better analyzed with CBCT. Furthermore, 37.1% believe that CBCT provides the best view of periodontal status, and 46.9% indicated that the temporomandibular joint (TMJ) is best viewed with CBCT. Interestingly, 47.3% of participants think that alginate impressions cannot be eliminated with the use of CBCT data. Additionally, 58.8% believe that CBCT can accurately show the exact location of mini implants, although they express concerns about radiation exposure. Regarding the type of field of view indicated for impacted canines, 40.5% stated that they do not know. Moreover, 62.2% of respondents indicated that CBCT cannot replace conventional X-rays. In terms of radiation exposure, 82.3% of participants believe that the same amount of radiation exposure poses the same risk of developing cancer for both adults and children. Furthermore, 60.5% think that CBCT radiation dose is less than that of a CT scan.

Table 1: Frequency distribution of CBCT courses and referral among Sudanese and Chinese general practitioners and orthodontists.

Response	Frequency	Percent
Did you ever refer your patients for CBCT imaging?		
All	11	3.7
Often	105	35.7
Occasionally	109	37.4
None	68	23.2
How did you come across the term CBCT?		
Internet	24	8.2
MSc lessons	53	18
Seminars and works hops	53	18
Undergraduate lectures	101	34.2
Others	63	29.8
Did you receive any training in CBCT during your undergraduate education?		
No	227	77.2
Yes	67	22.8
Did you receive training in CBCT in your postgraduate education?		
No	224	76.2
Yes	70	23.8
Have you attended any courses related to CBCT?		
No	232	78.0
Yes	62	21.1

Table 2: Knowledge toward CBCT among Sudanese and Chinese general practitioners and orthodontists.

Response		Frequency	Percent
What do you think are the advantages of CBCT??			
	Show the relationship between the anatomical structures more clearly	86	29.2
	Wider application range.	17	5.8
	The three-dimensional structure is more helpful for the clinical judgment of orthodontists.	125	42;5
	More details can be observed	62	21.1
	Others	4	1.3
Root resorption is seen better in?			
	Intraoral periapical radiography	55	18.7
	Orthopantomography	8	2.8
	Cone-beam computed tomography	174	59.2
	All of the above	57	19.3
Airway space is better analyzed in?			
	Lateral cephalogram	72	24.5
	CBCT	114	38.8
	Both	74	25.2
	None	22	7.5
	Other	12	4
Periodontal status can be best viewed by?			
	CBCT	109	67.1
	IOPA	48	16.3
	OPG	70	23.8
	All	61	20.7
	Others	6	2

TMJ can be best viewed by?			
	CBCT	138	46.9
	Panoramic radiography	16	5.4
	Lateral radiographs	36	12.2
	All of the above	85	28.9
	Others	19	6.5
Can alginate impressions be eliminated with the use of CBCT data?		139	47.3
	No	34	11.6
	Yes	121	41.4
	I don't know		
Can CBCT be used for determining the ideal location for mini-implant placement			
	No	5	1.7
	Yes	41	13.9
	Yes, but radiation exposure is a concern	173	58.8
	I do not know	75	25.5
If you want to take CBCT for impacted canine, what do you think is the suitable type of Field of View (FOV) of CBCT			
	Small FOV	66	22.4
	Medium FOV	71	24.1
	Large FOV	38	12.9
	I don't know	119	40.5
CBCT can be used to replace conventional lateral cephalogram and panoramic radiographs			
	True	111	37.8
	False	138	62.2
A 10-year-old child and 50-year-old adult exposed to the same dose of ionizing radiation incur the same risk of developing cancer			
	True	242	82.3
	False	52	17.7
The radiation dose and risk from CBCT is generally higher than the conventional dental radiography (Intraoral periapical, panoramic...) but lower than conventional CT scans			
	No	17	5.8
	Yes	178	60.5
	I don't know	99	33.7

Table 3: Awareness toward CBCT.

Response	Frequency	Percent %
Are you aware of Cone's beam computed tomography (CBCT) in dental radiology?		
No	31	10.5%
Yes	263	89.5%
An informed consent discussion with patient regarding CBCT is necessary?		
No	34	11.5%
No idea	95	32.4%
Yes	165	56.1%
It's necessary that dentist discuss CBCT radiation exposure with patients?		
No	43	14.6%
No idea	62	20.1%
Yes	189	64.3%

In Table 3, it is depicted that 89.5% of the respondents believed they possess awareness regarding Cone Beam Computed Tomography (CBCT) in dental radiology. Furthermore, a majority, accounting for 56.1%, consider it essential to engage in informed consent discussions with patients concerning CBCT. Additionally, 64.3% of the respondents express the opinion that it is necessary for dentists to discuss CBCT radiation exposure with their patients.

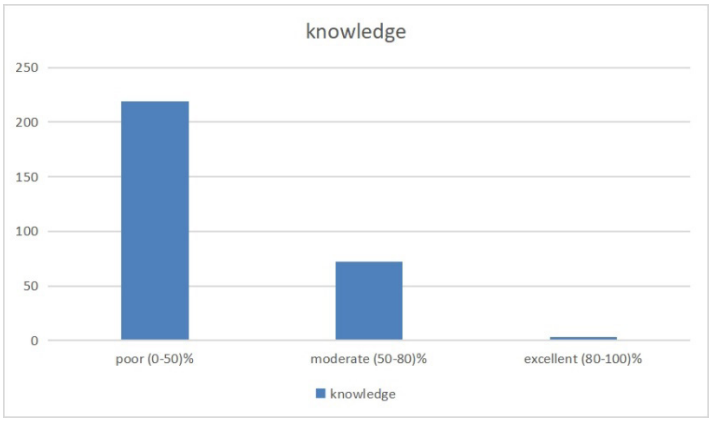

Figure 1: Knowledge levels toward CBCT among Sudanese and Chinese general practitioners and orthodontists.

Figure 1 illustrates the distribution of Knowledge scores, calculated as the percentage of correct answers out of the total of 11 knowledge questions. Among the participants, 219 individuals demonstrated poor knowledge (74%), scoring less than 50%. Additionally, 72 participants exhibited moderate knowledge (24.5%), scoring between 50% and less than 80% of the correct answers. Only 3 participants provided correct answers to more than 80% of the questions.

Comparisons between Sudanese and Chinese general practitioners and orthodontists

In Table 4, the comparison of knowledge levels between Sudanese and Chinese dental practitioners is presented. Among Sudanese general participants, 83.5% displayed poor knowledge, 15.7% had moderate knowledge, and 0.9% exhibited excellent knowledge. Similarly, 83.8% of Chinese general practitioners showed poor knowledge, with 16.2% having moderate knowledge, and none achieving excellent knowledge. No statistically significant difference was noted between Sudanese and Chinese practitioners ($P>0.05$). Furthermore, the comparison between Sudanese and Chinese orthodontists revealed notable distinctions. Sudanese orthodontists had a lower percentage of poor knowledge (28%) and a higher percentage of moderate knowledge (66%), with 5.1% demonstrating excellent knowledge. In contrast, 68.6% of Chinese orthodontists exhibited poor knowledge, 31.4% had moderate knowledge, and none achieved an excellent knowledge score, indicating a highly statistically significant difference between the two groups ($P<0.01$).

When comparing Sudanese general practitioners combined with orthodontists to their Chinese counterparts, 69.5% of Sudanese practitioners demonstrated poor knowledge, whereas 80% of Chinese practitioners exhibited poor knowledge. Additionally, 1.9% of Sudanese practitioners achieved an excellent score, while none of

the Chinese practitioners did. This outcome suggests a significant association between nationality and knowledge level (P<0.05).

Table 4: Comparison between Sudanese and Chinese participants in knowledge level toward CBCT.

Job position		Poor	Moderate	Excellent	Total	p-value
GP	Sudanese	96	18	1	115	0.6 NS
		83.5%	15.7%	0.9%	100.0%	
	Chinese	88	17	0	105	
		83.8%	16.2%	0.0%	100.0%	
	Total	184	35	1	220	
		83.6%	15.9%	0.5%	100.0%	
Orthodontist	Sudanese	11	26	2	39	0.000 S
		28.2%	66.7%	5.1%	100.0%	
	Chinese	24	11	0	35	
		68.6%	31.4%	0.0%	100.0%	
	Total	35	37	2	74	
		47.3%	50.0%	2.7%	100.0%	
Total	Sudanese	107	44	3	154	0.04 S
		69.5%	28.6%	1.9%	100.0%	
	Chinese	112	28	0	140	
		80.0%	20.0%	0.0%	100.0%	
	Total	219	72	3	294	
		74.5%	24.5%	1.0%	100.0%	

< 50: Poor, > 50 -80: Moderate. > 80: Excellent,
P< 0.05 *, p<0.01 **, P< 0.001: *** S: Significant. NS: Not significant.

Table 5 and Figures 2, 3, and 4 depict the awareness levels of Sudanese and Chinese dental practitioners regarding CBCT. Among Sudanese general practitioners, 74.8% demonstrated awareness, while a notably higher percentage of Chinese practitioners, 98.1%, were aware. Nationality was found to be significantly associated with awareness (P<0.001). However, when considering orthodontists, both Sudanese and Chinese practitioners exhibited full awareness of CBCT, with no significant difference observed (P>0.05).

Furthermore, upon combining general practitioners and orthodontists, 81.2% of Sudanese practitioners demonstrated awareness of CBCT in dental radiology, whereas a significantly higher proportion of Chinese practitioners, 98.6%, exhibited awareness. Nationality was highly significantly associated with awareness (P<0.001).

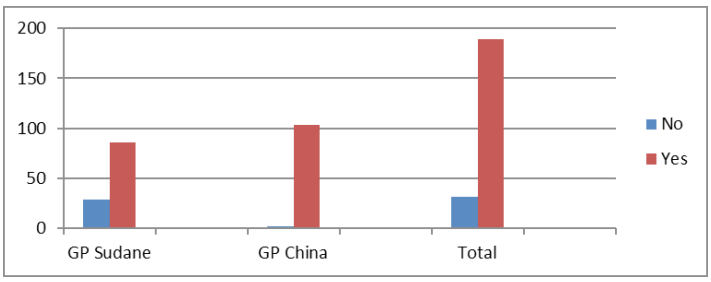

Figure 2: Frequency distribution and comparison between Sudanese and Chinese participants in awareness of CBCT. P<0.001.

Table 5: Comparison between Sudanese and Chinese participants in awareness of CBCT.

Job position		Are you aware of Cone beam computed tomography (CBCT) in dental radiology?		Total	p-value
		No	Yes		
GP	Sudanese	29	86	15	0.001 S
		25.2%	74.8%	100.0%	
	Chinese	2	103	105	
		1.9%	98.1%	100.0%	
	Total	31	189	220	
		14.1%	85.9%	100.0%	
Orthodontist	Sudanese	0	39	39	1 NS
		0	100.0%	100.0%	
	Chinese	0	35	35	
		0	100.0%	100.0%	
	Total	0	74	74	
		0	100.0%	100.0%	
Total	Sudanese	29	125	154	0.001 S
		18.8%	81.2%	100.0%	
	Chinese	2	138	140	
		1.4%	98.6%	100.0%	
	Total	31	263	294	
		10.5%	89.5%	100.0%	

P< 0.05 *, p<0.01 **, P< 0.001: *** S: Significant. NS: Not significant.

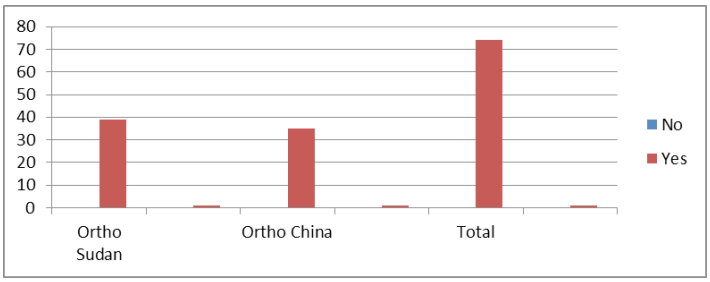

Figure 3: Frequency distribution and comparison between Sudanese and Chinese participants in awareness of CBCT P>0.05.

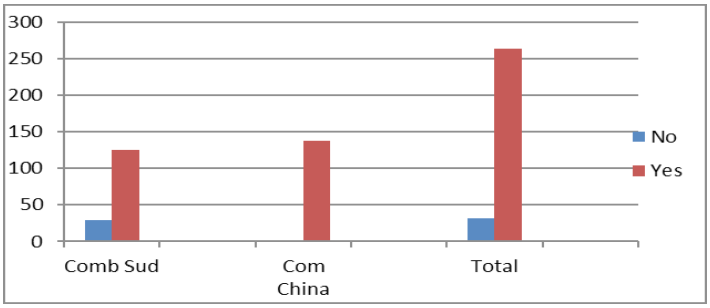

Figure 4: Frequency distribution and comparison between combined Sudanese (GP+ Orthodontist) and combined Chinese (GP+ Orthodontist) in awareness of CBCT.P<0.001.

Table 6 and Figures 5, 6, and 7 highlight the disparities in awareness regarding the necessity of consent forms for CBCT between Sudanese and Chinese dental practitioners. Among Sudanese general practitioners, 60% reported having no Idea of knowledge about consent forms, while a significant majority of Chinese

general practitioners, 84.8%, were aware of the requirement for consent forms. (P<0.001). Conversely, among orthodontists, 51.3% of Sudanese orthodontists were aware of the need for consent for CBCT, compared to 60% of Chinese orthodontists, with no significant difference observed (P<0.7).

On the other hand, concerning the necessity of an informed consent discussion with patients regarding CBCT, 52.6% of Sudanese participants (GP+ Orth. Combined) were unaware, while 78.6% of Chinese participants (GP +Ortho Combined) believed it was necessary. These findings indicate a higher degree of awareness among Chinese practitioners compared to Sudanese practitioners, with nationality significantly associated with this awareness (P<0.001).

Table 6: Comparison between Sudanese and Chinese participants regarding provision of consent for CBCT.

Job position		An informed consent discussion with patient regarding CBCT is necessary?			Total	p-value
		No	No idea	Yes		
GP	Sudanese	11	69	35	115	0.001 S
		9.6%	60.0%	30.4%	100.0%	
	Chinese	10	6	89	105	
		9.5%	5.7%	84.8%	100.0%	
	Total	21	75	124	220	
		9.5%	34.1%	56.4%	100.0%	
Orthodontist	Sudanese	7	12	20	39	0.7 NS
		17.9%	30.8%	51.3%	100.0%	
	Chinese	6	8	21	35	
		17.1%	22.9%	60.0%	100.0%	
	Total	13	20	41	74	
		17.6%	27.0%	55.4%	100%	
Total	Sudanese	18	81	55	154	0.001 S
		11.7%	52.6%	35.7%	100.0%	
	Chinese	16	14	110	140	
		11.4%	10.0%	78.6%	100.0%	
	Total	34	95	165	294	
		11.6%	32.3%	56.1%	100.0%	

P< 0.05 *, p<0.01 **, P< 0.001: *** S: Significant. NS: Not significant

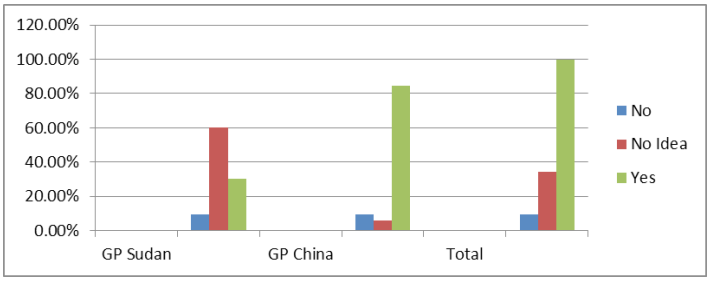

Figure 5: Frequency distribution and comparison in percentage between Sudanese and Chinese general practitioners regarding provision of consent form CBCT.P<0.001.

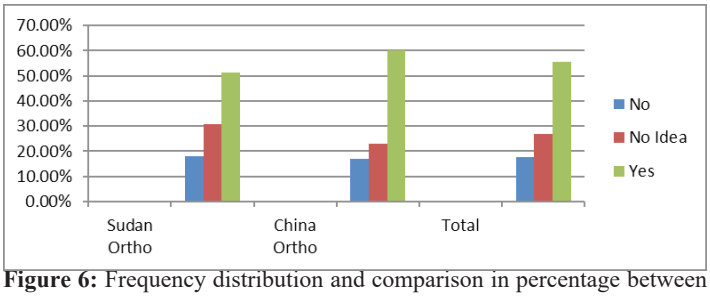

Figure 6: Frequency distribution and comparison in percentage between Sudanese and Chinese orthodontists regarding provision of consent form CBCT.P>0.05.

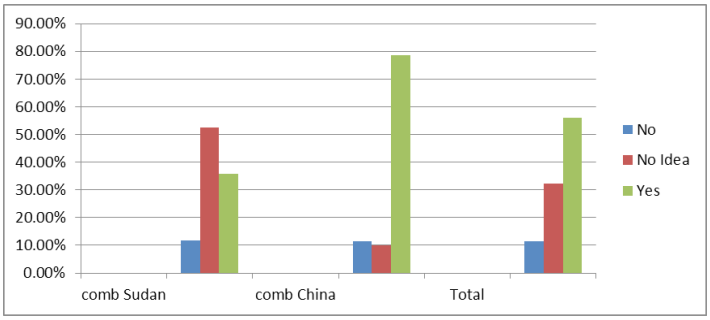

Figure 7: Frequency distribution and comparison in percentage between combine (Sudanese+ GP) and combined Chinese (orthodontist+ GP) regarding provision of consent form CBCT P<0.001.

Table 7 and Figures 8, 9, and 10 present the responses concerning the necessity of discussing radiation exposure from CBCT with patients among Sudanese and Chinese dental practitioners. Among Sudanese general practitioners, 30.4% answered "yes" to this question, whereas 84.8% of Chinese general practitioners did so. Similarly, among orthodontists, 61.5% of Sudanese practitioners answered "yes," compared to 57.1% of Chinese practitioners, with no significant difference observed (P>0.1).

When considering the responses from both general practitioners and orthodontists combined, 55.2% of Sudanese participants and 74.3% of Chinese participants believed that it is necessary for dentists to discuss CBCT radiation exposure with patients. These findings indicate a significant association between nationality and the perception of the necessity of discussing CBCT radiation exposure with patients (P<0.001).

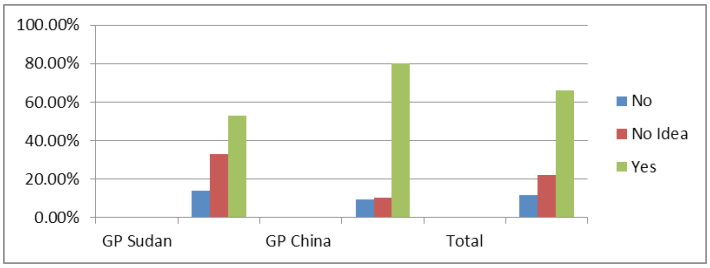

Figure 8: Frequency distribution and comparison in percentage between Sudanese and Chinese general practitioners regarding discussion of radiation exposure with patents (P< 0.001).

Table 7: Comparison between Sudanese and Chinese participants regarding discussion of radiation exposure with patents.

Job position		It's necessary that dentist discuss CBCT radiation exposure with patients?			Total	p-value
		No	No idea	Yes		
GP	Sudanese	11	69	35	115	0.001 S
		9.6%	60.0%	30.4%	100.0%	
	Chinese	10	6	89	105	
		9.5%	5.7%	84.8%	100.0%	
	Total	21	75	124	220	
		9.5%	34.1%	56.4%	100.0%	
Orthodontist	Sudanese	6	9	24	39	0.1NS
		15.4%	23.1%	61.5%	100.0%	
	Chinese	11	4	20	35	
		31.4%	11.4%	57.1%	100.0%	
	Total	17	13	44	74	
		23.0%	17.6%	59.5%	100.0%	
Total	Sudanese	22	47	85	154	0.001 S
		14.3%	30.5%	55.2%	100.0%	
	Chinese	21	15	104	140	
		15.0%	10.7%	74.3%	100.%	
	Total	43	62	189	294	
		14.6%	21.1%	64.3%	100.0%	

P< 0.05 *, p<0.01 **, P< 0.001: *** S: Significant. NS: Not significant.

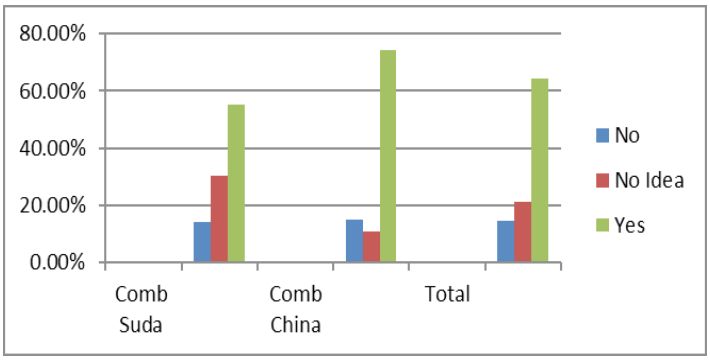

Figure 9: Frequency distribution and comparison in percentage between Sudanese and Chinese orthodontists regarding discussion of radiation exposure with patents (P.>0.05).

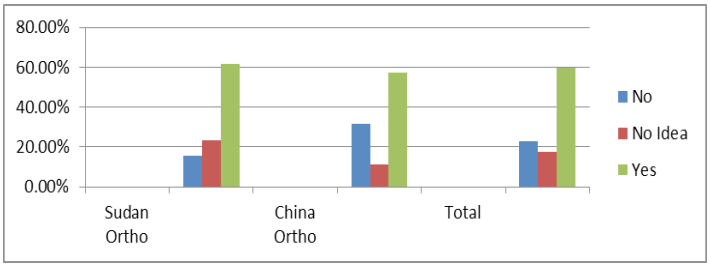

Figure 10: Frequency distribution and comparison in percentage between combine Sudanese (Orthodontists + GP) and combined Chinese (Orthodontists+ GP) regarding discussion of radiation exposure with patents (P< 0.001).

Table 8: Comparison between Sudanese and Chinese participants regarding knowledge.

Nationality		Knowledge			Total	p-value
		Poor	Moderate	Excellent		
Sudanese	General practitioner	96	18	1	115	0.001 S
		83.5%	15.7%	0.9%	100%	
	Orthodontist	11	26	2	39	
		8.2%	66.7%	5.1%	100%	
	Total	107	4	3	154	
		69.5%	28.6%	1.9%	100%	
Chinese	General practitioner	88	17	0	105	0.05 S
		83.8%	16.2%	0	100%	
	Orthodontist	4	11	0	35	
		68.6%	31.4%	0	100%	
	Total	112	28	0	140	
		80.0%	20.0%	0	100%	
Combined	General practitioner	184	35	1	220	0.001 S
		83.6%	15.9%	0.5%	100%	
	Orthodontist	35	37	2	74	
		47.3%	50.0%	2.7%	100.%	
	Total	219	72	3	294	
		74.5%	24.5%	1.0%	100%	

< 50: Poor, > 50 -80: Moderate. > 80: Excellent

P< 0.05 *, p<0.01 **, P< 0.001: *** S: Significant. NS: Not significant.

Table 8 and Figures 11, 12, and 13 provide a comparison of knowledge levels between Sudanese general practitioners (GPs) and Sudanese orthodontists, as well as between Chinese GPs and Chinese orthodontists. The findings reveal that Sudanese orthodontists possessed significantly better knowledge compared to Sudanese general practitioners (P< 0.001). Similarly, Chinese orthodontists exhibited superior knowledge compared to Chinese general practitioners (P<0.05).

Furthermore, when combining both Chinese and Sudanese orthodontists and comparing them with the combined group of Sudanese and Chinese general practitioners, the results indicated that the combined orthodontist group displayed a higher level of knowledge compared to the combined general practitioner group (P<0.001).

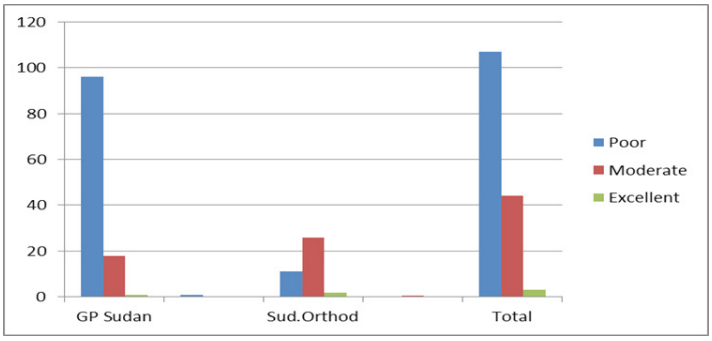

Figure 11: Frequency distribution and comparison of knowledge level between Sudanese general practitioner and Sudanese orthodontists.

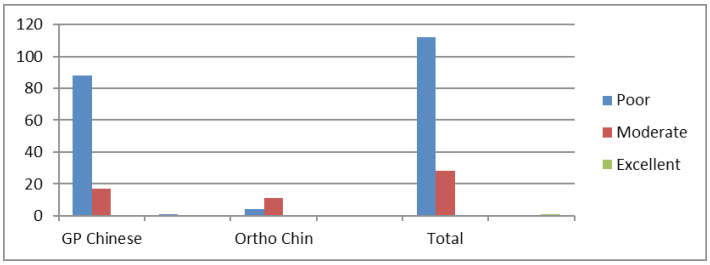

Figure 12: Frequency distribution and comparison of knowledge level between Chinese general practitioner and Chinese orthodontists P< 0.05.

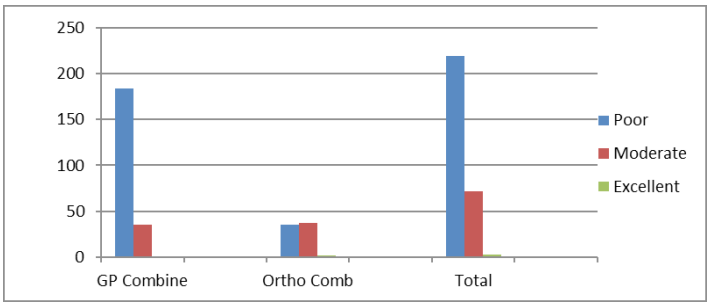

Figure 13: Frequency distribution and comparison of knowledge level between combined Sudanese general practitioner and Chinese general practitioners and combined Sudanese and Chinese orthodontists P< 0.001.

Discussion

In dental treatments, radiographic examination is very significant. According to the ALARA principle, the radiation dosage to the patient must be maintained as low as practically possible (ALARA stands for "as low as reasonably achievable"). This concept, as well as dose reduction measures, must be addressed in 3D imaging, particularly in the head and neck area [9]. Along with its minimal price, availability and accessibility, and reduced exposure to radiation, CBCT has evolved from a special tool in dental practice to a standard as well as common imaging technology for implant placement, orthodontics, oral and maxillofacial surgery, and root canal therapy, similar to several other technologies that were authorized by experts and patients while becoming maintained after being specialized [36]. Dental radiology research is mostly concerned with digital systems and radiation safety. Similarly, the current study sought to assess and compare general practitioners' and orthodontists' knowledge and awareness of CBCT in Sudan and China.

The majority of participants in this survey felt that the amount of radiation and hazard from CBCT is higher than that of traditional dental radiography but lower than that of conventional CT scans. In another research by Ghoncheh et al., which explored participants' perceptions of the order of radiation exposure, the majority of the participants believed that the intensity of radiation exposure in declining order was as follows: CT scan > CBCT scan > panoramic radiography [11]. Similarly, Ramani and Kalra found that the most significant advantage of CBCT over CT was the decreased radiation exposure to the patient [9]. Chau and Fung [37] Qirresh et al. [38]., Sudhakar et al. [39]. Balabaskaran and Srinivasan [40] as well as Honey et al. [41] all achieved consistent findings.

The majority of participants believe that CBCT is the best way to view the temporomandibular joint (TMJ) (46.9 percent). In a similar survey, respondents (67 percent) said they used CBCT to diagnose TMJ problems [22]. When comparing to panoramic radiography and linear tomography, Honey et al. reported that CBCT images offered a significantly more accurate and precise identification of condylar cortical erosion [42]. Hilgers et al. discovered that CBCT scans were more accurate and dependable than traditional linear cephalometric, postero-anterior, as well as submentovertex radiographs when analyzing linear measures of the TMJ [43].

Airway passages are better evaluated in CBCT, according to 38.8 percent of participants. Airway studies (reported by 28% of programs) used to rely on 2D cephalometric views, but CBCT imaging can now be used to estimate the cross-sectional area, volume, and length of airways. CBCT has been shown to be more precise than cephalometric images in measuring nasopharyngeal airway 3D volume (reference 34). Grauer et al. discovered substantial relationships between the antero-posterior jaw relationship and airway shapes/volumes [44].

More than half of the participants (59.2%) reported better assessment of root resorption could be done through CBCT. Panoramic radiography has traditionally been used to assess apical root resorption. Dudic et al. discovered that panoramic radiography underestimates the amount of resorption and proposed that CBCT images might benefit in both evaluation and therapy continuation or modification choices [45]. On the other hand, Le Levin and Jong claimed that while periapical and panoramic imaging can detect root resorption, they are not deemed legitimate due to the difficulties in distinguishing for both buccal and lingual surfaces, as well as the amount of the resorption [46].

The best way to determine periodontal condition, according to 37.1 percent of Sudanese and Chinese respondents, is to use CBCT. Sugumaran et al. found that 43.04 percent of Indians agreed that CBCT was the best method for determining periodontal health [47]. They mentioned that there was a possibility of overestimating the actual presence of fenestrations and dehiscence leading to unwanted treatment need when compare to a 2D image [48-50]. However, regarding the use of CBCT in place of alginate impression for digital study models, the result of the present study revealed that 47.3% denied using it. This was in disagreement with Sugumaran et al.'s result where 34.7% responded that CBCT can be used to produce 3D digital study models but they mentioned that CBCT study models have occlusal distortion. This drawback could be reduced and recommended the use of intraoral cameras or silicone impressions [51].

Alqerban et al. also discovered that CBCT is a considerably more sensitive method than panoramic radiographs for identifying impeded maxillary canine generated exterior root resorption of

the lateral incisors [52]. Panoramic radiography, according to Leuzinger et al., greatly overestimates neighboring root contacts, with just an 89 percent false positive rate [53].

Some items of the questionnaire are especially designed to measure participants' CBCT training. Less than half of the participants reported coming across CBCT in undergraduate lectures (34.2%). Majority (77.2%) denied learning CBCT in undergraduate studies. A nearly equal percentage (76.2%) denied receiving any training about CBCT in postgraduate studies. This reflects the poor curriculum provided for the dentistry undergraduate and postgraduate students in regard to imaging and new diagnostic technologies. Despite this, only 23.2% of the respondents reported not referring their patients for CBCT.

In the present study, 80% of all Chinese participants had poor knowledge whereas 69.5% of all Sudanese participants had. Hence, nationality and level of knowledge are significantly associated ($P<0.05$). However, when dividing the total sample of the Sudanese and Chinese to general practitioner and orthodontist groups, 83.5% and 83.8% of Sudanese general practitioners and Chinese GP showed poor knowledge respectively ($P>0.05$).

On the other hand, 66.7% of the Sudanese orthodontists revealed statistically significant moderate knowledge compared to 31.4% of the Chinese orthodontists. Hence, job position is significantly associated with knowledge level ($P<0.05$). This difference in the level of knowledge could be attributed to the fact that most of the participants reported insufficient curriculum and decreased practical training. Thus, it is recommended to increase the number of education programs and practical training, which will improve the level of knowledge on CBCT and subsequently enhance dental healthcare practice [25].

This research was initiated due to the apparent absence of clinical and didactic education in the field of CBCT in undergraduate and postgraduate dental curricula. Furthermore, the degree of familiarity with this technology among dental practitioners is unknown. Given that the interpretation of scans achieved by CBCT requires training, education, and experience, there exists the potential for error among practitioners attempting to read the resulting images. This highlights the necessity for formalized training for anyone involved in this type of imaging.

Last but not least, CBCT is a rather advanced imaging technique with a lot of promise in dentistry. Dental professionals are finally recognizing and accepting this truth. According to the study's findings, there is a large gap in dental professionals' awareness and expertise of CBCT applications. Dental specialists themselves have expressed a shortage of training in this discipline and have emphasized the importance of such training. Furthermore, nationality and job position were significantly associated with levels of knowledge.

Conclusions

The following conclusions can be drawn:

CBCT as a Diagnostic Tool: CBCT has demonstrated its value as a diagnostic tool not only in orthodontics but also in various other dental specialties.

Knowledge Levels among Participants

In Sudanese general participants, 83.5% had poor knowledge, 15.7% had moderate knowledge, and only 0.9% had excellent knowledge. Similarly, in Chinese general practitioners, 83.8% had poor knowledge, 16.2% had moderate knowledge, and none had excellent knowledge. No statistically significant difference was observed between the Sudanese and the Chinese ($P>0.05$).

Among orthodontists, 28.2% of Sudanese and 68.6% of Chinese had poor knowledge. 66.7% of Sudanese orthodontists and 31.4% of Chinese orthodontists had moderate knowledge. None of the Chinese orthodontists had an excellent score, while 5.1% of the Sudanese orthodontists scored excellent ($P<0.01$).

Awareness Levels

74.8% of Sudanese general practitioners were aware of CBCT, while 98.1% of Chinese general practitioners were highly aware ($P<0.001$).

100% of Sudanese orthodontists and Chinese orthodontists were fully aware of CBCT, with no significant difference observed ($P>0.05$).

Combining both Sudanese orthodontists and general practitioners, 81.2% were aware of CBCT, whereas 98.6% of the combined Chinese orthodontists and general practitioners were aware ($P<0.001$).

Comparative Analysis

Comparing the results with studies in different populations revealed both similar and dissimilar responses, indicating variations in knowledge and awareness levels across different regions.

Patient Safety Concerns

The lack of knowledge regarding CBCT among dental practitioners poses a risk of higher radiation exposure to patients. Therefore, it is crucial for practitioners to be well-informed about safety measures to ensure patient and clinician safety. Overall, these conclusions underscore the importance of enhancing education and training programs related to CBCT to improve knowledge and awareness levels among dental professionals and ultimately enhance patient care.

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