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Knowledge level of dentists and dental specialists on the use of dental portable x-ray

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ABSTRACT

Objectives: Portable X-ray is one of the mobile radiography equipment. It is made with special technological characteristics. It is designed for diagnostic purposes in areas that are far from health facilities. It is considered easy to use and also beneficial. This study aimed to assess the level of knowledge of general and dental specialists on the use, protection, and benefits of dental portable X-rays.

Materials and Methods: The study used a descriptive-analytic method design with a survey technique through a closed questionnaire distributed online to respondents in September 2024.

Results: This study netted 169 respondents with the results. For question category 1, 43.7% understood, and categories 2 and 3 were very well understood.

Conclusion: The understanding of portable X-ray is in the moderate category, its utilization is classified as very good, and the goal, understanding, and knowledge of radiation protection is good.

Keywords: *Portable x-ray, dental portable x-ray, dentist knowledge*
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INTRODUCTION

Since the early 20th Century, protection from the deleterious effects of ionizing radiation in diagnostic imaging examinations has been a much-discussed topic. At present, there is a consensus among safety agencies about the need to try, whenever possible, to reduce the levels of radiation to which professionals and patients are exposed, based on the ALARA (As Low As Reasonably Achievable), ALADA (As Low As Diagnostically Acceptable), and ALADAIP (As Low As Diagnostically Acceptable Being Indication-Oriented And Patient-Specific) principles.[1–4] Imaging technology in the field of diagnostic radiology is developing constantly, along with meeting the growing demand for community service needs. One form of technological development is the emergence of portable X-ray equipment with a small size that can produce images with better quality. Dental radiographs are an integral part of everyday clinical dentistry.[5] Radiographs are used to diagnose, treat, and evaluate dental caries, periodontal disease, temporomandibular joint disorders, and traumatic injuries.[6] Dental X-ray equipment is commonly fixed (on wall, floor, or ceiling mounted) or mobile (tripod mounted on a set of wheels). A fairly new concept is the handheld, battery-operated, portable X-ray unit, which has come on the market. In the past, the majority of the handheld, portable X-ray units were modified machines for use in military medicine, humanitarian missions, and training exercises.[5] A portable X-ray has characteristics of a device that is easy to carry and move, designed for patients who have limited movement to the radiology room. X-ray equipment can be operated directly by holding the X-ray device without using a tube support.[7,8]

Portable X-ray equipment is considered very helpful and useful for the diagnosis and monitoring of patients in intensive care units, nursing homes, prisons, homeless shelters, and other places where ordinary X-ray equipment is not possible.[1,5,8,9] This makes it an appealing option for use in a surgical center during operations, in forensic dentistry, community work, and home care.[5] Portable hand-held dental X-ray devices are currently used for forensic purposes and instances in which access to dental facilities is difficult or not possible, such as distant and deprived locations, nursing homes, and patients under general anesthesia. In addition, portable X-ray units can be used in mass disasters and for post-mortem analysis and identification.[10]

Handheld portable dental X-ray devices are

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used in dentistry for taking intraoral radiographs. The current handheld portable X-ray devices resemble a photographic camera or have a "shotgun" design. The devices are used as a replacement for wall-mounted or semi-mobile X-ray devices (on tripod or mobile support) and differ in two major characteristics from those the operator holds the handheld portable X-ray devices during exposure of the patient, so the operators cannot stand back and therefore dedicated means of the (scatter) radiation protection need to be provided. The newer handheld devices typically have a lower output dose rate (set by current, waveform, filtration, and cone length) than do the traditional wall-mounted direct current units.[1] The development of the portable hand-held dental X-ray device has led to several advantages, including a reduction in size and in weight, which allows for easy transportation to any required location.

However, despite its benefits, some risks must be considered from the use of portable X-ray equipment. Thus, the development of portable X-ray equipment technology must be accompanied by radiation protection measures to ensure radiation safety for patients, workers, and the general public.[7] The use of portable hand-held X-ray devices in routine dental care is not recommended due to the secondary radiation dose that the operator may receive during radiographic examinations.[5,9] This can reduce the optimization of radiation protection safety because there is a possibility of vibration or instability during operation. As a result, the quality of the images produced will decrease, and there is also the possibility of the operator's hands being exposed to unwanted radiation. In addition, several other things also need to be considered regarding the risks of using this portable X-ray equipment.[7,8]

Nevertheless, the proximity of the operator to the X-ray unit raises radiation safety concerns. In the previous research, leakage and scattered radiation were measured using a solid-state detector.[9] It is important to emphasize that radioprotection measures will only minimize the effective dose received by the professional if the operator holds the device during the examination. Only when portable hand-held dental x-ray devices are used on a stand and operated from a protected area (either 2 meters away or behind a barrier), similar to the usage of conventional radiographic devices, can operators be fully safeguarded against secondary radiation. Consequently, manufacturers should endeavor to create supports for portable devices that enable the operator to emit radiation from a safe distance.[4] With the increased use of portable hand-held X-ray devices in dentistry, concerns related to occupational radiation protection are being raised. Annual occupational radiation protection dose limits for dental workers are expressed as Total Dose Equivalent (TDE) or Effective Dose. The permitted TDE can vary depending on the anatomical region, ranging from 50 millisieverts (mSv) for the external whole body exposure dose to 500 mSv for external exposure of the skin or an extremity.[11]

The use of portable X-ray devices among general dentists and specialists in dentistry has become ubiquitous. In addition, tempting offers from the device distributors have raised the device consumption interest. The question persists, do operators understand the device's characteristics, indications, and safety precautions needed in the utilization. This experiment is done based on the dilemma above to evaluate the level of operators' comprehension as dentists and dental specialists, other than dentomaxillofacial radiology specialists, related to the device usage.

MATERIALS AND METHODS

The method used in this study is descriptive quantitative with a survey method. The data collection method uses a quantitative approach by assessing the understanding of respondents or samples, namely general practitioners and dental specialists, except dentomaxillofacial radiologists. The tool used is a questionnaire in the form of closed questions (closed-ended). The types of questions given are about general knowledge, usability, and protection from the use of portable X-ray equipment. Calculation of the number of samples using the Lemeshow formula, with a minimum sample size of as many as 96 people, and this study obtained 169 respondents within a period of one month. Respondents' knowledge was measured with two categories: not understanding (the total number of respondents who answered incorrectly) and understanding (the total respondents who answered correctly) for each question category. Drawing from recent health education and radiology knowledge assessment frameworks, levels of understanding can be stratified as follows: not understanding (< 50% of correct responses), moderate understanding (50-74% of correct responses), well understanding (75-89% of correct responses), and very well understanding (≥ 90% of correct responses). The categories for questionnaire scoring were 0 false and 1 true.[12]

The study employed a structured questionnaire comprising three validated categories (Cronbach's alpha = 0.855; all factor loadings > 0.361), each addressing distinct dimensions of knowledge. Questioner type 1: items assessing general knowledge of portable X-ray devices (e.g., definition, design, and basic characteristics). Questioner type 2: Items assessing clinical applications and benefits, including indications, diagnostic value, and advantages over conventional wall-mounted units. Questioner type 3: Items assessing radiation protection and safety, covering ALARA/ ALADA principles, dose limits, and protective measures for operators and patients. Data that has been obtained through questionnaires is processed through editing (checking data), coding (giving a code to each answer with numbers), and entry (entering data into tables).[13] After that, the data will be analyzed using simple statistical techniques.

RESULTS

The study was conducted to determine the level of knowledge of the respondents regarding the utilization of portable X-rays.

Table 1. Characteristics of Respondents' Education and Place of Work

	Frequency	Percent	Valid Percent
General Practice	158	93.5	93.5
Dental Specialist	11	6.5	6.5
Total	**169**	**100**	**100**
Clinic	41	24.3	24.3
Other	51	30.2	30.2
Private Practice	12	7.1	7.1
Community Health Center	26	15.4	15.4
Hospital	39	23.1	23.1
Total	**169**	**100**	**100**

Table 1 shows that the respondents were general practitioners, as many as 158 respondents, and dental specialists, except dentomaxillofacial radiologists, consisting of 11 respondents. The workplace of the respondents varied from clinics 41 respondents, private practices 12 respondents, community health centers 26 respondents, hospitals 39 respondents, and the remaining 51 respondents. Based on the data, many respondents filled in others, which means that the possibility of a workplace does not fit the category, or respondents are reluctant to know exactly where the location of their workplace is. This does not affect the research results.

Table 2. Validity Test of the Questionnaire

Category	R Count	Information
Questionnaire Type 1	0.394 to 0.772	Valid
Questionnaire Type 2	0,410 to 0.708	Valid
Questionnaire Type 3	0,462 To 0.772	Valid

R table: 0.361

The independent variable in the study is the knowledge of general dentists and dental specialists, and the dependent variable (the variable to be observed or measured) is knowledge about dental portable X-rays. Based on the validity test in Table 2, the results obtained, the factor loading value of the entire questionnaire is above the R Table (0.361). This means that all question items are valid and can be used.

The reliability test was carried out using a questionnaire that had been declared valid in the validity test, and its reliability was determined. The variable is declared reliable with the following criteria: a. reliable if the Cronbach's Alpha value> 0.6, and if the Cronbach's Alpha value <0.6, then it is not reliable.

Table 3. Reliability Test of the Questionnaire

Variable	Cronbach's Alpha	Information
P1 to P15	0.855	Reliable

Based on the reliability test in Table 3, the results of the Cronbach alpha value of all variables are above 0.6, which means that all questionnaires are reliable to use.

Table 4. Results of respondents' answers for each question category

Item	Questionnaire Category 1		Questionnaire Category 2		Questionnaire Category 3	
	n	%	n	%	n	%
Questionnaire 1						
Yes	162	95,9	109	64,5	164	97
No	7	4,1	60	35,5	5	3

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Item	Questionnaire Category 1		Questionnaire Category 2		Questionnaire Category 3	
	n	%	n	%	n	%
Questionnaire 2						
Yes	81	47,9	135	79,9	169	100
No	88	52,1	34	20,1	0	0
Questionnaire 3						
Yes	54	32	114	67,5	30	17,8
No	115	68	55	32,5	139	82,2
Questionnaire 4						
Yes	10	5,9	120	71	163	9,4
No	159	94,1	49	29	6	
Questionnaire 5						
Yes	62	36,7	45	73,4	87	51,5
No	107	63,3	124	26,6	82	48,5

Table 4 describes the distribution of respondents' answers (Yes/No) across five questionnaire items categorized into three thematic categories. Overall, the data indicate strong agreement among respondents for certain items, particularly Question 1 and Question 2, which show high percentages of "Yes" responses across all categories—reaching up to 100% in some cases—suggesting a strong consensus and clarity in these items. In contrast, items such as Question 3 and Question 5 exhibit more variation in responses, reflecting possible ambiguity or differences in interpretation depending on the context. Notably, Question 4 demonstrates a dramatic increase in agreement across categories, indicating that context plays a significant role in shaping respondents' perceptions. These patterns highlight that while some items are robust and well-aligned with respondent expectations, others may require refinement to ensure clarity and consistency across different contexts.

Table 5. Results of Respondent Analysis

Type Questionnaire	Not understand	Understand
Category 1	56%	44%
Category 2	38%	62%
Category 3	38%	72%

Table 5 describes the characteristics of the answers from all respondents. From the data, it can be seen that respondents generally lack understanding about portable X-ray equipment, but respondents can freely guess the uses and benefits of this tool, which is used to produce intraoral radiographs. Respondents were also generally quite familiar with radiation protection and hazards.

DISCUSSION

The data from Table 4 are the questions about the knowledge of dental portable X-ray. There are five questions for each category, for a total of 15 questions. The first question category is answered correctly by the respondents (95.9% yes, 4.1% no). Dental examinations are an integral part of daily dental care. Historically, machines were wall-mounted (WM)/stationary devices and used in specialized examination rooms, due to complicated procedures and protections. The use of portable X-rays was mostly for immobilized, disabled, and terminally ill patients for whom radiographic examinations were impossible.[14] The advent of portable X-ray devices, such as the Nomad Pro 2, offers a simple size, easy operational technique, and enables bedside dental X-ray imaging in hospitals and nursing homes. Therefore, there is much scientific debate regarding the safety, image quality, and accuracy of X-ray devices.[13,15]

Knowledge of the device is required for use. The results of the study showed that the knowledge about this device was not very good. This means that of all respondents, only about 43.7% understand this equipment. This means that many dentists do not know this device clearly, and research on knowledge about this device has not been found. Each case of use of a portable X-ray device should be conducted by a licensed person, and a report should be made on the type of device, the precise reason, the amount of exposure dose, and the protective measures taken. A good practitioner will document each use. With the resulting level of knowledge, the understanding of the use of this device still needs socialization. Respondents' knowledge was mostly obtained through social media, so the respondents' knowledge of dental portable X-ray was at a moderate level. The role of a dentist is very important to provide knowledge about dental portable X-ray. The results of research related to understanding radiation protection showed quite good results with 62% which can be interpreted as understanding, even though not all understand. Radiation protection needs to be considered, especially in the use of portable X-rays.

Based on calculations made by Kartika (2020), the dose rate at a distance of 10 cm from the surface of the focal point with a time of 0.5 seconds in the position with the smallest dose (0.003 µSv) is 21.6 µSv / hour.[1] This exceeds the limit required by Government Regulation No. 29 of 2008 (1 µSv / hour). Government Regulation No. 29 of 2008, Article 72, contains provisions regarding ionizing radiation generation. It states that under normal operating conditions, the equivalent dose rate shall not exceed one µSv/hour at a distance of 10 cm.[16] Based on Government Regulation No. 29/2008 Article 72, portable X-ray equipment is not included in the license-exempt uses because the dose rate exceeds one µSv/hour at a distance of 10 cm. Therefore, factory-made portable X-ray equipment must be licensed by BAPETEN.

So it is necessary to make provisions or guidelines to optimize radiation protection and safety in the use of portable X-ray equipment to ensure radiation protection and safety. In addition, utilization of portable X-ray equipment cannot be done without proper justification from the doctor.[17,18] Portable X-ray equipment often changes places, so it is necessary to have provisions for tracking the location of portable X-ray equipment to monitor the safety of its use. This can be done by limiting the location area as stated in the use permit. The area may include districts, cities, or provinces. In addition, there needs to be a regular reporting system to BAPETEN about the location of portable X-ray equipment. However, supervision related to the area needs to be coordinated with the Ministry of Health or the local Health Office because portable X-ray equipment is a form of health service that must be integrated with health facilities.[18]

The limitation of this research is response bias; participants may provide socially desirable responses, impacting data quality. Since this is online survey research, there is potential sample bias due to internet access limitations.

CONCLUSION

The level of knowledge among dentists about portable dental X-ray, according to the survey, was moderate. Socialization and information on social media can help to improve knowledge about dental portable X-ray. The goal of this research is to improve the understanding and knowledge of radiation protection, which is quite good.

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FOOTNOTES

All authors have no potential conflict of interest to declare for this article.

This article does not contain any studies with human or animal subjects performed by any of the authors.

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