The use of hand-held X-ray equipment among Dentists and Dental Specialists in Gauteng Province

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ABSTRACT:

Introduction

Handheld intraoral x ray units were created for use where fixed units are impractical. Their global popularity has grown; however, there are concerns about exposure times, scattered radiation and inadequate safety practices. Limited South African research prompted this study to bring awareness and safe usage of hand-held X-ray equipment by dental clinicians.

Aims and Objectives

To investigate the use of handheld x ray equipment and determine if they are being operated correctly and safely.

Design

A quantitative, descriptive, cross-sectional study.

Methods

The study was conducted in public and private dental clinics in Gauteng, South Africa. General dentists and dental specialists were recruited through non-probability sampling. Data were collected using a self-administered online questionnaire. Statistical analysis was performed using the IBM-STSS statistical software, including frequencies, descriptive statistics, and cross-tabulation to compare categorical variables.

Results

There were 144 responses, giving a response rate of 19.02%. 6,3% of dentists used handheld X-ray units. No correlation was noted between dentists' years of experience and the type of intraoral X-ray unit used.

Conclusion

This study highlights handheld X-ray use. Ongoing education, strict adherence to radiation safety protocols, and regular compliance monitoring are essential to ensure the safety of patients and operators.

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Key words

Hand-held X-ray equipment; SAHPRA; intra-oral X-ray units; radiation safety

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Brigitte Walsh	30%
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INTRODUCTION

Intraoral X-ray units are widely used in dentistry and are acknowledged to be the gold standard for the detection of periapical lesions[1]. In Gauteng, the wealthiest province in South Africa, 93% of dentists are equipped with intraoral X-ray units[2,3]. The first portable intraoral X-ray equipment was developed in 1993.[4] It was designed to be used in areas where fixed intraoral X-ray units could not be used.[5] A portable unit has multiple areas of application, including forensics, nursing homes, prisons, outreach programmes, remote areas, immobile patients and in emergencies such as mass fatalities.[6,7]

The portability of the handheld X-ray units (Figure 1) has led to their use becoming increasingly popular worldwide. However, due to the longer exposure time required by handheld X-ray units, concerns have been raised regarding the increase in radiation scatter and the lack of appropriate radiation safety measures by dentists when using these units.[5] Furthermore, many literary debates have arisen over the quality of intraoral radiographs taken using a fixed-mounted intraoral X-ray unit in comparison to a handheld X-ray unit; however, the main concern amongst users of this equipment is the level of scatter radiation emanating from handheld X-ray units.[6] The matter of holding an intraoral receptor by any member of the dental team during exposure is of significant concern, as it results in a large amount of scatter radiation affecting the hands of the operator, caused by backscatter and scatter from the patient's head.[8] The portability of these units has also raised security and equipment safety concerns due to the ease with which they can be dropped or fall off a counter.[9]

The advantage of handheld intraoral X-ray units is that they are easily accessible, cost-effective, cordless, and allow for flexibility, as one unit can be used in multiple surgeries.[5] With the appropriate use of intraoral positioning devices, which assist in reducing radiation dose, the operator can stay in the room during the X-ray procedure. This can be advantageous when handling paediatric patients and patients who are anxious [5].

Figure 1: Handheld X-ray camera[10]

In South Africa, there are stringent regulations governing the usage of handheld X-ray units.[11] According to the South African Health Products Regulatory Authority (SAHPRA), handheld X-ray devices may only be operated by dentists or diagnostic radiographers, and regardless of the level of exposure, both the operator and patient must wear radiation protective apparel[11]. This is due to the non-standardised patient positioning techniques that are often required to improve radiation safety when using handheld X-ray units. Dosimeters are mandatory for radiographers and dentists who perform more than 100 intraoral radiographs per week using fixed installations.[11] This legislation also states that dosimeters must always be worn when operating a handheld X-ray device, regardless of the number of exposures obtained. Notwithstanding the legislation, there is little published material on the usage of handheld X-ray units in South Africa. There is a lack of research on handheld X-ray units in South Africa; therefore, this study aimed to explore the types of X-ray equipment, specifically handheld X-ray units used by general dentists and dental specialists, to provide radiation guidelines for the use of handheld X-ray units by SAHPRA.

METHODS

Research Setting

This study was conducted in both public and private dental clinics in Gauteng, South Africa, where general dentists and dental specialists were actively practising.

Research Design

A quantitative, descriptive, and cross-sectional design was adopted to explore the radiographic imaging methods employed by dentists and dental specialists in the region. At the time of data collection, approximately 2,739 dentists were registered in Gauteng, comprising 2,459 general dentists and 280 dental specialists.[12] A non-probability convenience sampling approach was used within a quasi-experimental framework.[13] In consultation with a university-affiliated statistician, a minimum sample size of 100 participants was determined to achieve statistical significance.

Data Collection

Data was collected using a self-administered online questionnaire, adapted from validated instruments in previous studies.[14–17] The questionnaire was distributed via email and social media platforms (e.g., WhatsApp®), targeting dental practitioners and professional associations. Contact details were obtained from online directories and peer networks.

Initially, the survey was hosted on REDCap®,[18] a secure electronic data capture system. However, due to a low response rate and feedback regarding usability, the survey was reformatted and reissued via Google Forms®. While Google Forms offered greater accessibility, it raised data privacy concerns; therefore, the survey was closed once the desired sample size was reached.[19]

A pilot study was conducted with three participants: two public-sector general dentists (one academic, one service-focused) and a dental specialist working in both sectors. The pilot aimed to assess the survey's functionality across various devices. Minor issues related to grammar, layout, and response scale formatting were identified. The comments and feedback from the pilot study were used to amend and improve the survey. Data from the pilot were excluded from the main analysis.

Data analysis

The REDCap® platform yielded 66 responses. After transitioning to Google Forms®, an additional 122 responses were collected, resulting in a total of 188 submissions. The survey data were encoded as continuous values (e.g., Yes = 1, No = 2) and processed using the survey platform's data management system. Incomplete questionnaires with no responses were excluded, while partial responses (n = 12) were retained due to their informative value, resulting in a final sample size of 144. Statistical analysis was performed using the IBM-STSS statistical software. The statistical analysis included frequencies, descriptive statistics, and cross-tabulation to compare categorical variables.

Ethical approval for this study was obtained from the University of Johannesburg Research Ethics Committee (REC-1769-2022). Subsequent permission to conduct the research among dentists and dental specialists employed by the Gauteng Department of Health was granted by the National Health Research Database (NHRD) (Reference: 2022_10_0222)

RESULTS

There were 144 responses received, giving a response rate of 19.02%. All general dentists and dental specialists who are currently practising in the public and/or private sector in Gauteng were invited to participate in the study. The current number of practising dentists in Gauteng was estimated to be 2739.[12] The dental specialities included community dentistry, maxillofacial and oral surgery, oral pathology, orthodontics, prosthodontics, oral medicine, and periodontology. All dentists and dental specialists who were not practising in Gauteng were excluded from this study. In this study, 96.6% of respondents confirmed that they were dentists and were currently practising in Gauteng, and the remaining 3.4% of respondents confirmed that they were not dentists or were not practising in Gauteng. Responses from the latter group were discarded.

Table I: Demographic data

		Frequency	Percentage
Age Category of Dentists	Less than 30 years	19	13.2%
	31 - 40 years	44	30.6%
	41 - 50 years	31	21.5%
	51 - 60 years	30	20.8%
	61 and over	20	13.9%
	TOTAL	**144**	**100.0%**
Sex of Dentists	Male	75	52.1%
	Female	68	47.2%
	Prefer not to say	1	0.7%
	TOTAL	144	100.0%

The largest group, including 30.6% of the dentists, fell between the ages of 31 and 40. Additionally, 13.9% of the dentists were over the age of 60. Of the dentists, 52.2% were male and 47.2% were female.

Table II: Business Practices of Dentists

		Frequency	Percentage
Type of Business	Public Sector	36	25.0%
	Private Sector	86	59.7%
	Both	22	15.3%
	Total	**144**	**100.0%**
Type of Practice	Individual	68	42.0%
	Group	53	32.7%
	Teaching Institution	40	24.7%
	Other	1	0.6%
	Total	**162***	**100.0%**
Type of Dentist	General Dentist	112	77.8%
	Specialist	32	22.2%
	Total	**144**	**100.0%**
Years of Professional Experience	Up to 5 years	21	14.6%
	5 – 10 years	30	20.8%
	11 – 20 years	38	26.4%
	More than 20 years	55	38.2%
	Total	**144**	**100.0%**

The majority of respondents worked exclusively in the private sector (59.7%). A quarter of the dentists were employed exclusively in the public sector, while 15% of them were engaged in both the public and private sectors. *The number of responses regarding the type of practice is higher, as some dentists work in more than one practice and were therefore not limited to only denoting one response. The largest proportion of dentists (42%) was employed in individual practices, while 32.7% worked in group practices and 24.7% were affiliated with teaching institutions. The study found that 77.8% of the respondents were classified as general dentists, while the remaining 22.2% were categorised as dental 51 specialists. A total of 35.4% of the dentists reported having 10 years or less of professional work experience as dentists, compared to 38.2% of the dentists who indicated having worked in the profession for more than 20 years.

Table III: Type of Intraoral X-ray Unit

		Frequency	Percentage
Type of Intraoral X-ray Unit	Fixed/ mounted X-ray unit	118	93,7%
	Handheld X-ray unit	8	6,3%
	Total	126	100,0%

A small minority, 6,3% of dentists, use handheld X-ray units. The majority (93,7%) of dentists used fixed-mounted intraoral X-ray units.

Table IV: Type of Intraoral X-ray Used According to Years of Professional Experience

			Type of Intraoral X-ray Unit		
			Fixed/ Mounted X-ray Unit	Handheld X-ray Unit	Total
Years of Professional Experience	10 years or younger	Count	43	3	46
		Percentage	93,5%	6,5%	100,0%
	More than 10 years	Count	75	5	80
		Percentage	93,8%	6,3%	100,0%
	Total	Count	118	8	126
		Percentage	93,7%	6,3%	100,0%

There was no correlation noted between the dentists' years of experience and the type of intraoral X-ray unit that they use (phi=1.000). Most dentists (>93%) in both cohorts preferred fixed/ mounted intraoral X-ray units.

DISCUSSION

South Africa has a large rural population and challenging access to dental radiography. Thus, handhold X-ray equipment could be advantageous although this is not reflected in the current study where only a very small percentage of participants identified using handheld equipment. Despite these practical advantages, radiation safety remains one of the most significant concerns surrounding the use of handheld X-ray units. Previous studies conducted in South Africa have highlighted the low levels

of radiation safety awareness among dentists and dental experts [20]. International patterns of handheld X-ray use appear to reflect regulatory influences. In both Australia and the United States, the use of handheld X-ray units continues to grow, while in Europe, adoption remains limited due to stringent radiation safety regulations.[21,22] In Korea, 15% of dentists report using handheld units, compared with 11.9% in Morocco.[2,23] Previous studies in Korea and Morocco have raised concerns regarding the lack of radiation awareness among dentists in Korea and Morocco, respectively. In line with these findings, participants in the current study also identified radiation dose as a significant concern.[2,23]

In this study, only 6.3% of Gauteng dentists reported using handheld X-ray units, with the overwhelming majority (93.7%) relying on fixed intraoral units. A possible explanation for this could be the strict regulatory environment established by SAHPRA,[11] which requires both the patient and operator to wear lead aprons when using handheld X-ray units. In South Africa, dentists are required to wear radiation dosimeters when performing more than 100 intraoral radiographs per week when using fixed intraoral X-ray units. In the case of handheld units, however, radiation dosimeters must be worn at all times, irrespective of exposure frequency.[11] These legal stipulations, combined with inherent safety and security risks, may help explain the limited uptake of handheld X-ray units in this study population.

SAHPRA further specifies that fixed intraoral units may be operated by dentists, radiographers, and oral hygienists, whereas handheld units are restricted to dentists and radiographers.[11] This restriction likely reflects concerns around the lack of standardised positioning techniques needed to optimise radiation safety during handheld use. Evidence regarding the safety of handheld X-ray devices is mixed. Some studies indicate that they can be used safely provided that all recommended precautions are followed.[21] Other studies, however, report that while patient equivalent dose is lower with handheld X-ray units, operator exposure tends to be higher than with wall-mounted intraoral X-ray units.[22,24,25] Despite the small difference in radiation dose to the operator between the two types of X-ray units, handheld X-ray units should only be used where the use of a fixed intraoral X-ray unit is not possible and should never be used in place of a fixed X-ray unit.[5,7,24,26] This supports the very small percentage of uptake of handheld X-ray devices seen in the present study.

Further testing across 14 handheld models has shown that operator exposure varies depending on the device's structural design.[27] Another critical factor is the operator's positioning relative to the unit.[28] To minimise radiation dose, the central ray should be aligned along the horizontal plane, perpendicular to the image receptor and close to the area of interest.[27] The device should also be held as far away from the operator as possible.[29] Over time, operator fatigue may cause the arms to bend, thereby reducing the distance between the operator and the device.[27]

LIMITATIONS

The study was only conducted in the Gauteng province; a South African study across all nine provinces would be valuable. The response rate for the study was low. Specific questions were not asked regarding why handheld devices are not a popular choice of equipment in Gauteng.

RECOMMENDATIONS:

- Conduct further research into the uptake of handheld devices and their challenges to direct future training.
- Expand the research to include all nine provinces.
- Consider a qualitative research study to address the factors affecting the use of handheld devices in individual interviews.

CONCLUSION

This study provides important insights into the use of handheld X-ray units among dentists in Gauteng. The findings reveal that only 6.3% of dentists utilise handheld devices, while the overwhelming majority (93.7%) rely on fixed intraoral units. The low uptake of handheld X-ray equipment appears to be influenced by strict regulatory requirements set by SAHPRA, which mandate the use of lead aprons for both operator and patient, restrict operation to dentists and radiographers, and require the consistent use of dosimeters. These stipulations, combined with the recognised risks of non-standardised positioning and operator radiation exposure, likely contribute to the reluctance to adopt handheld units in clinical practice.

The demographic and professional profile of respondents further contextualises these findings. Dentists across a range of age groups, genders, practice settings, and years of experience demonstrated a clear preference for fixed installations, with no correlation observed between experience and device choice. This suggests that external regulatory and safety considerations, rather than professional background, are the primary drivers of equipment selection.

Although international studies have demonstrated safe use of handheld X-ray units when strict protocols are followed, evidence also indicates increased operator exposure compared to wall-mounted units. Taken together, these findings highlight that handheld X-ray units may be valuable in specific scenarios where fixed installations are impractical or unavailable, but they should not replace fixed equipment in routine practice. Ongoing education, strict adherence to radiation safety protocols, and continued monitoring of compliance remain critical to ensuring both patient and operator safety.

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CONFLICT OF INTEREST:

The authors declare that they have no conflict of interest related to any aspect of this research project.

REFERENCES:

1. Arslan ZB, Demir H, Yıldız DB, Yaşar F. Diagnostic accuracy of panoramic radiography and ultrasonography in detecting periapical lesions using periapical radiography as a gold standard. Dentomaxillofacial Radiology. 2020;49(6):20190290. doi:10.1259/DMFR.20190290.
2. Elmorabit N, Obtel M, Azougagh M, Ennibi O. Radiation Protection Knowledge and Practices Among Moroccan Dentists: A Cross-sectional Study. Radiat Med Prot. 2024;(March):4–11. doi: 10.1016/j.radmp.2024.03.001
3. Gangavati R, Baad R, Vibhute N, Varma S, Kamte W, Sankpal S. An Insight into the Radiographic Practice Among Dentists of Karad City, India. European Journal of Pharmaceutical and Medical Research. 2016;3(3):368–73.
4. Pauwels R, Del Rey YC. Attitude of Brazilian dentists and dental students regarding the future role of artificial intelligence in oral radiology: A multicenter survey. Dentomaxillofacial Radiology. 2021;50(5). doi:10.1259/dmfr.20200461.
5. Geist JR. Handheld intraoral dental x-ray devices should supplement but not replace conventional radiographic equipment. Oral Surg Oral Med Oral Pathol Oral Radiol. 2021;132(3):257–9. doi: 10.1016/j.oooo.2021.06.001.
6. Lommen J, Schorn L, Nitschke J, et al. Accuracy in positioning of dental X-ray images – A comparative study of a portable X-ray device and a wall-mounted device. Saudi Dental Journal. 2021;33(8):884–9. doi: 10.1016/j.sdentj.2021.09.018
7. Ramesh D, Wale M, Thriveni R, Byatnal A. Handheld Xray Device: A Review. Journal of Indian Academy Oral Med Radiol. 2018; 30:153–7. doi: 10.4103/jiaomr.jiaomr
8. Whaites E, Drage N. Essentials of Dental Radiology for Dental Care Professionals. 6th ed. London: Churchill Livingstone; 2020.

9. Hoogeveen RC, Ouchene S, Wer B. Diagnostic image quality of hand-held and wall-mounted X-ray devices in bitewing radiography: A non-inferiority clinical trial. Dentomaxillofacial Radiology. 2021;50(5). doi:10.1259/dmfr.20200471.
10. Lion's Dental Supply & Equipment. RexTar-X Handheld X-Ray Unit. Riverside, California. Accessed on Oct, 6 2023[Internet]. Available from: https://lionsdentalsupply.com/RexTar-X-Handheld-X-Ray-Unit.html#gsc.tab=0
11. South African Health Products Regulatory Authority. Guideline for Dental Radiography. Document SAHPGL-RDN-XR-03, Version 1; Aug 2022, p 1-7. Available from: https://www.sahpra.org.za/document/dental-radiography-guidelines/SAHPRA.
12. Tiwarii R, Bhayati A, Chikte U. Forecasting for the need of dentists and specialists in South Africa until 2030. PLoS One. 2021; 16:1–14. doi: 10.1371/journal.pone.0251238.
13. Adams R, Adeleke F, Anderson D, et al. Discussion Document POPIA Code of Conduct for Research. 2021;117(5):1–12. doi: 10.17159/sajs.2021/10933 1
14. Masyte V, Sefeldaite S, Venskutonis T. A Questionnaire of Digital Radiography and CBCT Use and Knowledge among Lithuanian Dentists. J Oral Maxillofac Res. 2021;12(1):1–14. doi:10.5037/jomr.2021.12102
15. Mauthe PW, Eaton KA. An Investigation into Dental Digital Radiography in Dental Practices in West Kent Following the Introduction of the 2006 NHS General Dental Services Contract. Prim Dent Care. 2011;18(2):73–81. doi:10.1308/135576111795162893.
16. Hasan A, Naz F, Ali SA, Khan JA, Ali B. Technical Errors in Intra Oral Radiographs Obtained in Endodontic Department of a Teaching Dental Hospital. Journal of the Pakistan Dental Association. 2019;28(02):50–4. doi:10.25301/jpda.282.50
17. Samejo I, Kumar B, Musharraf H, Ahmed J, Memon L, Bhatti R. Assessment of Knowledge and Perspective Toward Dental Radiography Among Dental Practitioners of Sindh Province Pakistan. J Evol Med Dent Sci. 2021;10(29):2186–92. doi:10.14260/jemds/2021/447
18. Harris PA, Taylor R, Minor BL, et al. The REDCap Consortium: Building an International Community of Software Platform Partners. J Biomed Inform. 2019;95(May):103208. doi: 10.1016/j.jbi.2019.103208.
19. Raju V, Harinarayana NS. Online survey tools: A case study of Google Forms. Scientific, Computational & Information Research Trends in Engineering. Mysore; 2016. p. 1. Available from: https://www.researchgate.net/publication/326831738
20. Vilborn P, Uys A, Yakoob Z, Cronje T. Evaluation of radiation awareness among oral health care providers in South Africa. South African Dental Journal. 2021;76(3):122–8. doi: 10.17159/2519-0105/2021/v76no3a1.
21. Leadbeatter J, Diffey J. Evaluation of radiation exposure to operators of portable hand-held dental X-ray units. Phys Eng Sci Med. 2021;44(2):377–85. doi:10.1007/s13246-021-00985-5.
22. Nitschke J, Schorn L, Holtmann H, et al. Image quality of a portable X-ray device (Nomad Pro 2) compared to a wall-mounted device in intraoral radiography. Oral Radiol. 2021;37(2):224–30. doi:10.1007/s11282-020-00434-1.
23. An SY, Lee KM, Lee JS. Korean dentists' perceptions and attitudes regarding radiation safety and protection. Dentomaxillofacial Radiology. 2018;47(3):1–8. doi: 10.1259/dmfr.20170228.
24. Smith R, Tremblay R, Wardlaw GM. Evaluation of stray radiation to the operator for five hand-held dental X-ray devices. Dentomaxillofacial Radiology. 2019;48(5). doi:10.1259/dmfr.20180301.
25. Dillon JR, Johnson B, Broome A, Ivanovic M, Ludlow J. A Comparison of Contemporary Portable X-ray Systems. [Chapel Hill]: University of North Carolina; 2020.
26. Ivanović A. The utilization of a handheld X-ray device for intraoral imaging in modern dental practice. Radiološki vjesnik. 2024;48(1):33–8. doi:10.55378/rv.48.1.5
27. Otaka Y, Harata Y, Izawa M, et al. Comparison of Operator Exposure Dose in Portable Intraoral X-Ray Devices and Dose Management. Romanian Journal of Legal Medicine. 2023;31(2):138–44. doi:10.4323/rjlm.2023.138
28. Almeida F, Majeed M, Fossen A, Pacheco-Pereira C. Exploring hand-held dental X-ray devices and their impact on digital dentistry: rationale and best practices. The Canadian Journal of Dental Hygiene. University of Alberta; 2026;1-12.
29. Martins GC, Rocha TG, de Lima Azeredo T, de Castro Domingos A, Visconti MA, Villoria EM. Hand-held dental X-ray device: Attention to correct use. Imaging Sci Dent. 2023;53(3):265–6. doi:10.5624/isd.20230137

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