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Evaluation of Local Diagnostic Reference Levels (DRLs) for Panoramic X-Ray Examinations in Ambulatory Healthcare Services (AHS) Dental Clinics in Abu Dhabi, UAE

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Abstract: - *Background*: Panoramic radiography, a widely used imaging technique in dental settings, offers a comprehensive view of the maxillofacial region. However, ionizing radiation in dental radiography raises significant concerns about patient safety, particularly in the pediatric population, due to their higher radiosensitivity [1]. In recognition of our shared responsibility, this study aimed to establish local diagnostic reference levels (DRLs) that consider the specific patient population and clinical practices within a given healthcare system, ensuring the safe and responsible use of panoramic X-ray examinations. The study specifically looked at the radiation doses patients received during panoramic X-ray exams at Ambulatory Healthcare Services (AHS) dental clinics in Abu Dhabi, UAE, and the levels of optimization that accompanied them. Methods: This collaborative study evaluated the diagnostic reference values for pediatric and adult patients undergoing panoramic dental examinations. The dose area product (DAP) data were collected for actual patients using the panoramic unit system.

Results: The mean dose area product values for the adult panoramic X-ray examinations ranged from 32.97 to 97 (mGy.cm^2), and for the pediatric panoramic X-ray examinations, they ranged from 29.85 to 73 (mGy.cm^2). These results are numbers and the local diagnostic reference levels (DRLs) for dental panoramic radiography for pediatric and adults at 62.39 and 84 (mGy cm^2), respectively. This is an essential standard for the safe and responsible use of panoramic X-ray exams, with direct implications for patient radiation protection and medical imaging optimization in Abu Dhabi, UAE. This research is particularly relevant for healthcare professionals, radiologists, dental practitioners, and policymakers.

Keywords*: Dental Radiography, Diagnostic Reference Levels, Panoramic X-ray, Radiation Dose, and Patient Radiation Protection.*

1. Introduction

Ionizing radiation in diagnostic medical imaging has become integral to modern healthcare. Radiation exposure from medical imaging procedures, especially in pediatric patients, is a significant public health concern due to the increased risk of radiation-induced tissue damage and long-term stochastic effects, such as cancer [2] [3] . To address these concerns, the International Commission on Radiological Protection (ICRP) and other regulatory bodies have established guidelines and diagnostic reference levels (DRLs) to optimize radiation protection[4].

One area where radiation exposure is of particular concern is dental imaging, specifically panoramic X-ray examinations. Panoramic X-rays are widely used in dentistry for various diagnostic purposes, including assessing tooth and jaw development, evaluating dental implants, and identifying pathological conditions. Despite the potential benefits, panoramic X-ray examinations can also lead to significant radiation exposure, particularly for pediatric patients, due to their increased radiosensitivity and the higher exposure of larger anatomical areas.

Diagnostic reference levels (DRLs) optimize radiation doses in medical imaging examinations [5]. While the International Commission on Radiological Protection (ICRP) provides general recommendations, our study takes a unique approach by evaluating the current dose to establish local diagnostic reference levels for panoramic X-ray examinations in Ambulatory Healthcare Services dental clinics in Abu Dhabi, UAE. This focus on the local context and patient population is a novel contribution to dental radiography, which was not introduced in the UAE prior to this study.

2. Materials and Methods

Ethical approval was obtained from the Ambulatory Healthcare Services (AHS) Human Research Committee at the Department of Health in Abu Dhabi, UAE. The study was conducted in fifteen Ambulatory Healthcare Services dentistry clinics in Abu Dhabi, UAE. The dose area product DAP was determined for a typical sample of individuals receiving panoramic X-ray exams [6] .

This study identified the DRL in panoramic X-rays by calculating the karma area product (PKA), or DAP, representing how much radiation the panoramic system delivers to patients. It was employed as a technique for calculating real dose values for individuals receiving radiation doses using OPG procedures. A survey was circulated among dental personnel, requesting information such as the name of the clinic, the manufacturer of the dental equipment, the most frequently used protocols, the age of the patients, the classification of patients (adult or pediatric), and the exposure parameters for the protocols (tube kVp, mA, exposure time, DAP, or Kerma Area Product (KAP) in mGy.cm^2. Every group recorded the dose area product (DAP) for standard exposure in adult and pediatric patients. Following the recommendations of ICRP 135, this study has gathered the median values of DAP (dose area product) from a panorama machine system. The median values were acquired from a minimum of 20 readings. The diagnostic reference levels (DRLs) were determined at the 75th percentile using Microsoft spreadsheets from these median readings[4].

Before commencing DRL assessment work, all selected X-ray units must pass Quality Assurance (QA) tests to guarantee they function properly[6].

The optimization level was determined based on the dose measurement results to ensure that the dosages administered to patients were as low as possible [7] .

Panoramic X-ray machines must operate according to manufacturer specifications and licensing authorities to guarantee that patients do not get excessive radiation doses during radiological exams [8] . As a result, dental clinics that use panoramic X-ray systems must develop a quality control (QC) program [9]. The American Association of Physicists in Medicine (AAPM) Task Group report No. 175 defines the components of a quality control program for dental machines, such as intraoral, panoramic, and cephalometric imaging systems.

Figure 1 shows one of the tests that medical physicists must perform as part of their quality assurance (QA) tests. A medical physicist can correctly position the sensor in the narrow X-ray field of the panoramic device and attach the holder to the X-ray machine, as shown in Figure 1. Exposure is then performed using gafchromic film to detect the position of the X-ray beam. Gafchromic films are designed to provide fast and highly accurate measurements for X-ray applications, such as precisely determining the radiation path.

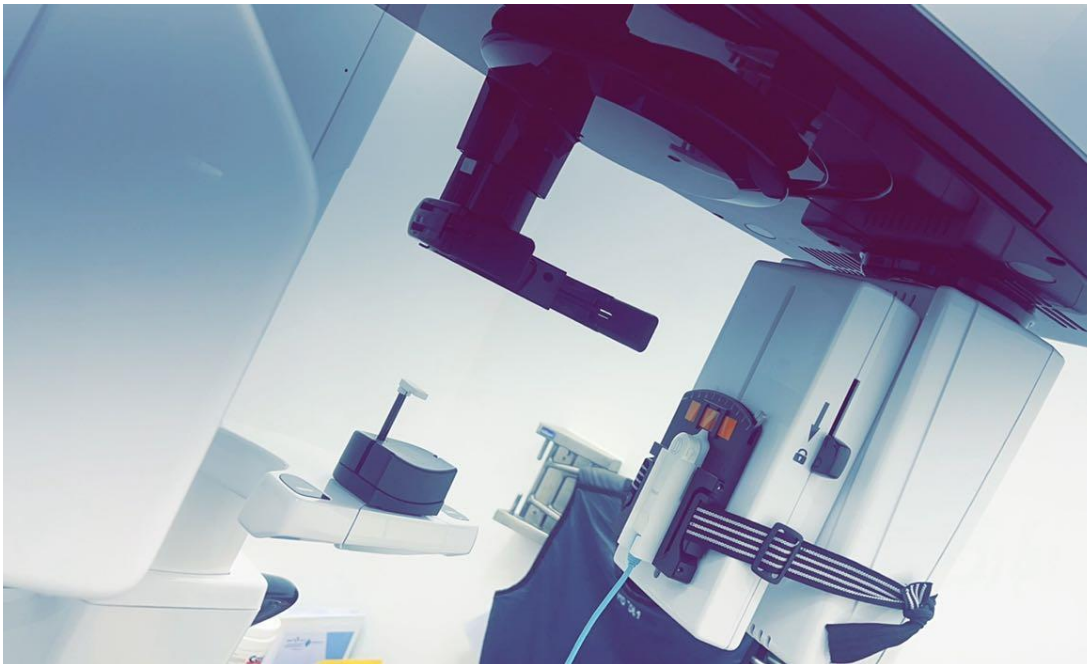


Fig 1: Pictorial representation of measurement of Tube voltage kVp, Output, and Timer Accuracy in the panoramic machine.

Table 1 shows the median, third quartile, maximum, and minimum dose area product (DAP) for panoramic examinations standard in dental centers and healthcare clinics in Abu Dhabi.

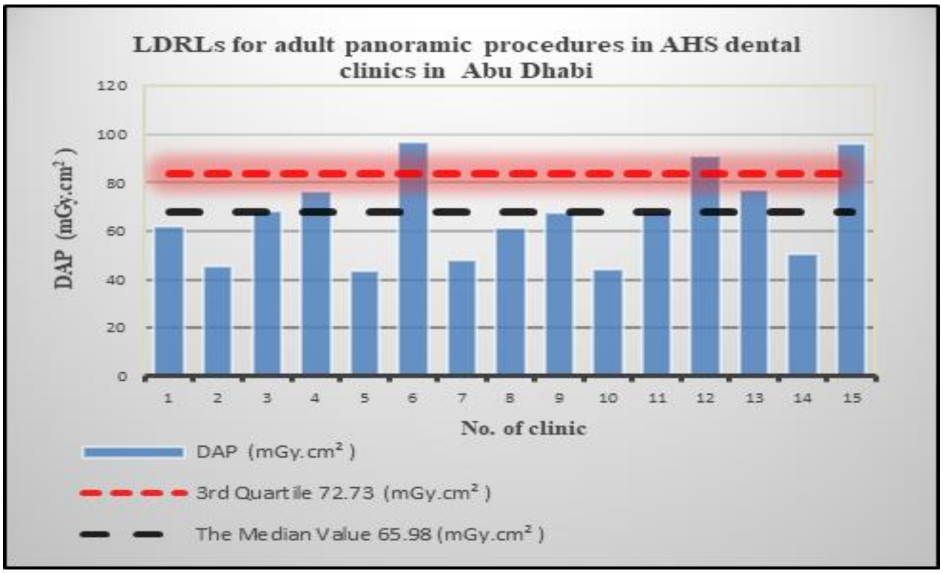
Table 1. Proposed LDRL (third quartile VALUES) FOR Panoramic X-ray Examinations in Ambulatory Healthcare Services (AHS) Dental Clinics in Abu Dhabi clinics.

Examinations	Average DAP value (Gy cm^2)	Third quartile DAP value (mGy.cm^2)	Max DAP value (mGy.cm^2)	Min DAP value (mGy.cm^2)
Adult Panoramic (full jaw)	67.79	84	97	32.97
Pediatric Panoramic (full jaw)	50.61	62.39	73	29.85

3. Results

The median dose area product for adult panoramic X-ray examinations was 68.59 (mGy.cm^2), and the 75th percentile was 84 (mGy.cm^2). This is acceptable compared to another country's international diagnostic reference level. The median dose area product for pediatric panoramic X-ray examinations was 50.61 (mGy.cm2), and the 75th percentile was 62.39 (mGy.cm^2). The examinations yielded satisfactory image quality, demonstrating appropriate optimization. The maximum median DAP dose value for adults is approximately 97 (mGy.cm^2), while the minimum median DAP dose value is 32.97 (mGy.cm^2) as shown in table1. On the other hand, the maximum value of the average DAP dose in pediatrics ranged around 73 (mGy.cm^2), while the minimum value was 29.85 (mGy.cm^2).

Figure 2 shows the graphical representation of the proposed DRLs for panoramic examinations. It represents the identified DRL by summing the (DAP) values from the system of fifteen panoramic units.



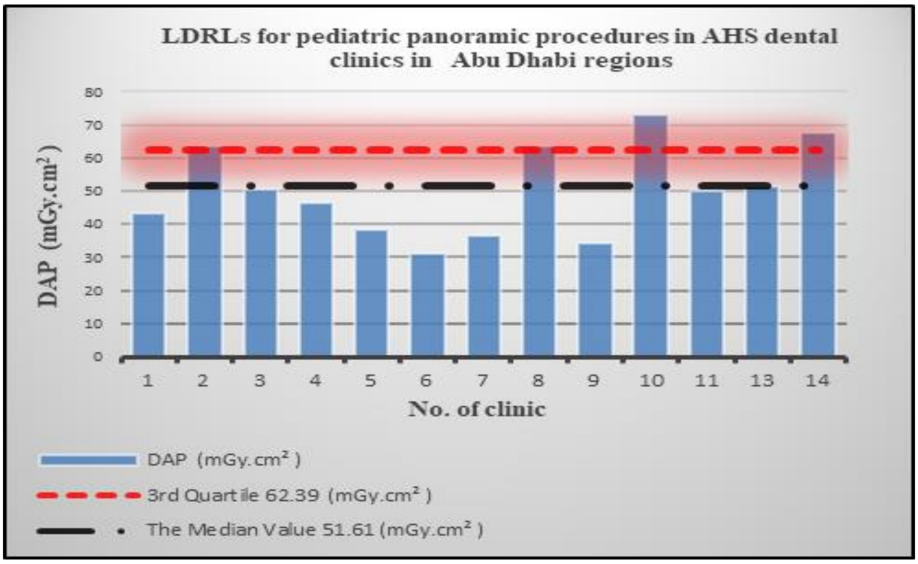


Fig 1: The graphical representation of the proposed LDRLs for Panoramic X-ray Examinations in Ambulatory Healthcare Services (AHS) Dental Clinics in Abu Dhabi

Table 2 compares the panoramic procedures DRLs proposed in this study to those suggested by other countries.

Table 2. Comparison of the panoramic LDRLs in (mGy.cm^2) obtained in this study with other countries.

Examinations	India 2021 [10]	Kosovo 2019 [11]	UK (2017) [12]	Sudan 2018 [13]	Saudi Arabia 2022 [14]	Kolombia 2019 [15]	This study 2024
Adult Panoramic	-	74.1	81	103.4	92.3	103.9	84
Pediatric Panoramic	82	62.7	60	70.4	72.7	-	62.39

4. Discussion

The present study evaluated the local diagnostic reference levels for panoramic X-ray examinations in Ambulatory Healthcare Services dental clinics in Abu Dhabi, UAE. Compared with the DRLs mentioned in the literature, the values obtained were close to some of the values mentioned in some countries. Still, they were also considered acceptable values and not high compared to those proposed in other countries., suggesting that the clinics have optimized their panoramic X-ray protocols and delivered radiation doses as low as reasonably achievable to patients.

The results of this study are consistent with previous studies that have reported lower radiation doses for panoramic X-ray examinations compared to published DRLs.

The lower radiation doses observed in this study can be attributed to the dental clinics' optimization efforts, which include [specific optimization efforts] and appropriate exposure parameters, collimation, and other dose-reduction techniques.

The data collection process revealed that certain clinics used higher levels, necessitating a collaborative action plan. This plan, which was developed with the input and expertise of all stakeholders, aimed to reduce these levels and was as follows:

Identifying the clinics with higher radiation doses and investigating the factors contributing to the higher doses, such as outdated equipment, inappropriate exposure parameters, or a lack of staff training.

Implementing a comprehensive quality assurance program, including regular equipment calibration, image quality assessment, and staff training, to ensure consistent optimization of radiation doses across all clinics.

Establishing a proactive process for regular monitoring and reviewing of radiation doses, focusing on identifying and addressing any outliers or high-dose clinics, demonstrates our commitment to maintaining the highest safety and quality standards.

Cooperation with the manufacturer's engineers to scrutinize the machine and ascertain the reason behind the rise in readings. After the examination, a meeting was held with one of the dentists and the machine's radiology technician. They repeated the examination, modifying the image quality to satisfy all parties.

5. Conclusion

Our study has comprehensively evaluated the local diagnostic reference levels for panoramic X-ray examinations in Ambulatory Healthcare Services dental clinics in Abu Dhabi, UAE. The findings reveal that the current radiation dose levels are [specific levels], and their potential health risks include [specific risks], which are essential in dental healthcare. They underscore the necessity of establishing and evaluating local DRLs to ensure the ongoing optimization of radiation doses in dental healthcare settings.

While the results are encouraging, it is paramount to continue vigilantly monitoring and optimizing radiation doses in these clinics. This ongoing effort is crucial to ensuring that an achieved levels are maintained, and further improvements are made, enhancing patient safety.

Future research, a beacon of hope in our collective effort, could build on this study and delve deeper into the factors contributing to lower radiation doses, such as digital imaging, exposure parameters, and staff training. Another area of improvement could be the establishment of local DRLs for other dental imaging modalities, such as cone-beam computed tomography. This study is considered a key start for implementing National DRLs for dental services to ensure comprehensive radiation dose optimization in dental healthcare services. [16].

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

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