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Research Article

Assessment of Local Diagnostic Reference Levels (DRLs) for Intraoral X-Ray Examinations of Ambulatory Healthcare Services AHS Dental Clinics in Al-Ain Regions

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Abstract

The present study aims to propose a set of local diagnostic reference levels (DRLs) for pediatric and adult intraoral radiography procedures classified by common dental exams in Ambulatory Healthcare Services (AHS) dental centers and healthcare clinics in the Al-Ain region of the UAE. The data collection for this study was done on 21 digital intraoral units. The third quartile values from the dose median obtained for the selected intraoral radiography examinations ranged from 0.2768 mGy for the pediatrics periapical X-rays (anterior) to 1.451 mGy for the adults Bitewing X-rays. The DRLs of the present study compare well with other international standards published in DRLs. After this initial study, an update of national diagnostic reference levels (DRLs) for intraoral radiography in dentistry will be suggested for more areas of the UAE by developing a standardized benchmark.

Keywords: DRL; Dental Radiology; Intraoral; Adult dental DRLs; Pediatric Dental DRLs; Optimization; Radiation Safety

Introduction

Radiography is considered an essential tool in dentistry, but recent reports and studies have raised concerns about its use due to the dramatic increase in the number of people visiting dental clinics for treatment or cosmetic gum surgery procedures, as well as the publication of numerous reports and studies suggesting possible overuse and overdose of radiation in some healthcare settings. All of that has raised concerns among patients and practitioners about the widespread use of radiation and its risks [1]. The term "optimization" refers to ensuring that the dose delivered to the patient is the lowest necessary for getting the appropriate diagnostic imaging output. A DRL is a patient dose level defined in ICRP 135 as a level of patient exposure for a typical examination of a group of standard-sized individuals using a wide range of types of equipment (DRLs) are radiation dose values for specific X-ray examinations that, assuming appropriate radiography practice is followed, should not be routinely exceeded for average-

sized individuals. They are not dose limits but recommendations; however, corrective measures should be pursued if they are consistently exceeded. DRLs were initially used in the UK four decades ago and have recently been shown to be an effective dose-reduction technique, with radiation levels reducing by 16% (from 2000 to 2005 surveys) and 50% in the UK since their use in the 1980s [2]. In addition, diagnostic reference levels (DRLs) are a dose optimization tool in medical imaging. The International Commission on Radiological Protection (ICRP), the American College of Radiology, the American Association of Physicists in Medicine, the Health Protection Agency, and the International Atomic Energy Agency are just a few prestigious professional and international organizations that support these levels.

According to new research, frequent dental X-ray exposure may increase the risk of thyroid cancer and malignancies of the tissue surrounding the brain and spinal cord. Patients are exposed to comparatively small doses of radiation during dental X-rays. Survivors of the Hiroshima atomic bombing, on the other hand, present evidence of an elevated risk of cancer due to modest doses of radiation. Repeated exposure can also raise the risk of developing cancer [3]. Dr. Jamila Al Suwaidi, et al. have conducted studies in the UAE [4-7] and [8] showed that patients and radiologists of all types have become more knowledgeable about radiation safety, dosimetry, and the biological effects of radiation, as well as the causes of cancer and DRLs. However, dental radiography has not received significant attention due to its low radiation dose. Therefore, limits and controls must be set for dental radiation doses called DRLs [9]. Dental bitewing X-ray dosages increased 400%, while full-mouth series and panoramic X-ray doses climbed 200% [10].

Patients and medical staff are at risk from any dental procedure or medical treatment using ionizing radiation. Therefore, most international organizations focused on radiation safety, like the UAE's Federal Authority for Nuclear Regulation (FANR) has implemented laws, recommendations, and regulations mandating Diagnostic Reference Levels (DRLs) across diagnostic medicine. DRLs are a requirement for all health institutions in the UAE, and they believe that all exposures should be kept as low as possible to reduce these risks [11,12] FANR has made it mandatory for all health institutions that use radiation; therefore, this study will determine the DRLs for common intraoral procedures in the Al-Ain regions. DRLs are also a method for boosting radiation-based medical imaging techniques. It also provides an estimate of the radiation dose a patient of average size receives when undergoing a particular imaging technique when applied correctly in dentistry, where it can significantly minimize radiation doses to patients.

Materials and Methods

The data were collected in 2024 from 5 Ambulatory Healthcare Services (AHS) healthcare centers and the dental centers in the Al-Ain region, selecting 21 intraoral dental radiology units for analysis. The incident air kerma (Ka,i) in mGy was measured by applying the protocol exposure parameters for adults and pediatrics according to the study's protocol values. It is very important to have a clear, accurate, and easy-to-use method for determining a patient's radiation dose. In oral radiology, imaging can be done with different X-ray machines. Each of these methods works differently and makes images differently. It is essential to have a clear, accurate, and easy-to-use method for determining a patient's radiation dose. In oral radiology, imaging can be done with different X-ray machines. Each of these methods works differently and makes images differently. As a result, different dosimetric methods must be used to measure the amount of radiation given to a patient. Table 1 shows how the amount used in practice varies depending on the imaging method [13].

Table 1: Specific quantities for patient estimation in dental radiology [13].

Dose quantity	Modality	Symbol	Common abbreviation	Unit
Incident air kerma	Intraoral radiography	K_i	IAK	mGy
Entrance surface air kerma	Intraoral radiography	K_e	ESAK, ESD	mGy
Air kerma–area product	Panoramic radiography, cephalometric radiography, CBCT	P_{KA}	KAP, DAP	mGy·cm^2
Air kerma– length product *	CT, panoramic radiography	P_{KL}	DLP	mGy·mm
CT air kerma index	CT, CBCT	C	CTDI	mGy
*: Also termed 'dose width product' for dental panoramic radiography. Note: CBCT — cone beam computed tomography; CT — computed tomography				

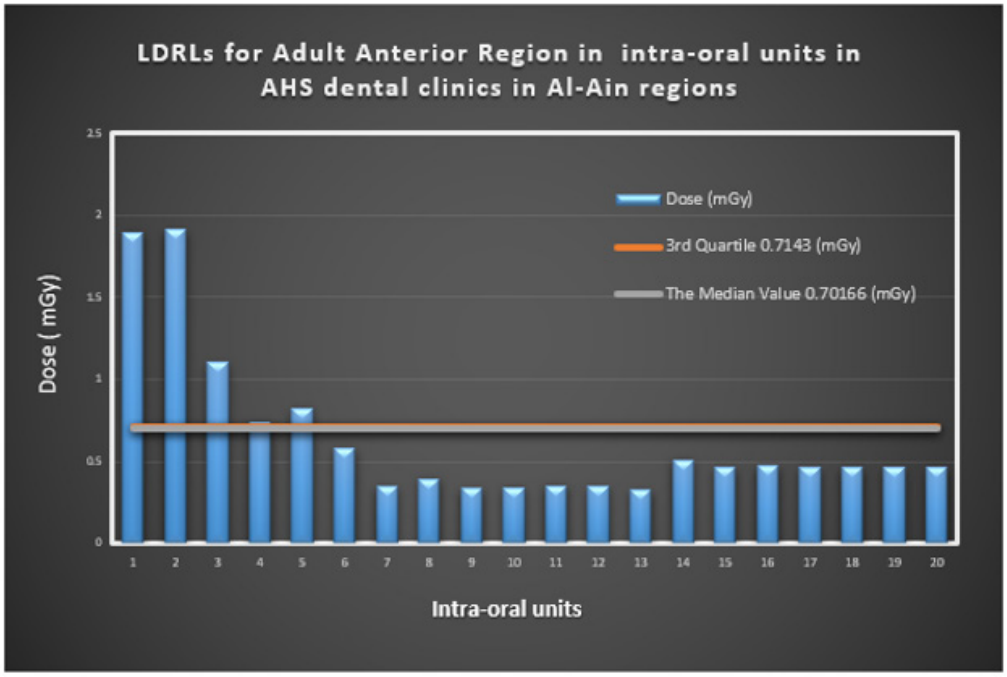
This study's methodology was similar to that of medical physicists from all over the UAE, who conducted it in 2015 [6]. It aimed to investigate the dosages administered to pediatric and adult patients using various dental radiology techniques. The study chose the most common intraoral dental exams conducted in dental centers in Al-Ain as follows (Table 2):

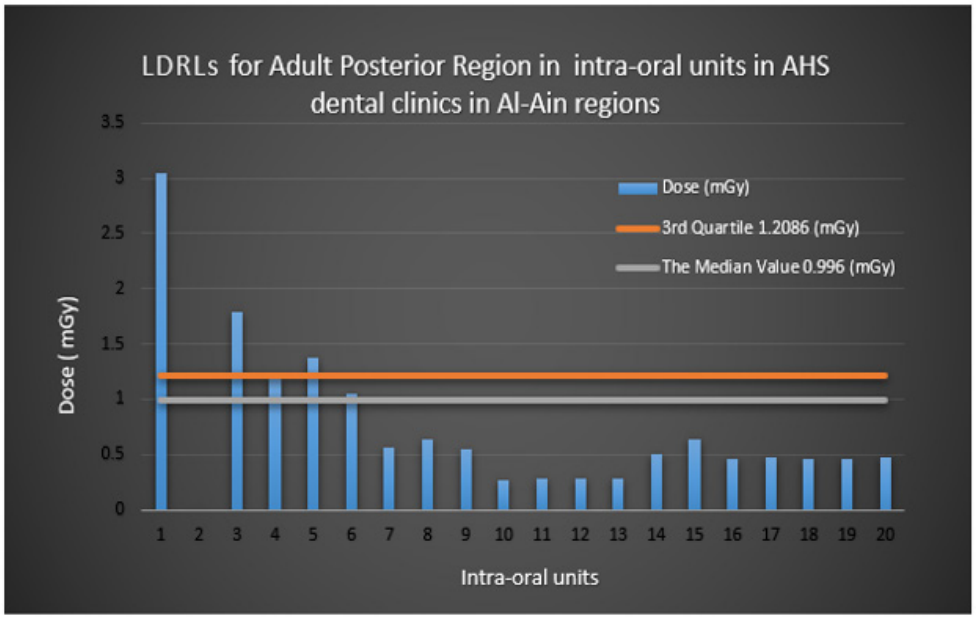
Table 2: Common dental exams in dental centers and healthcare clinics in Al-Ain.

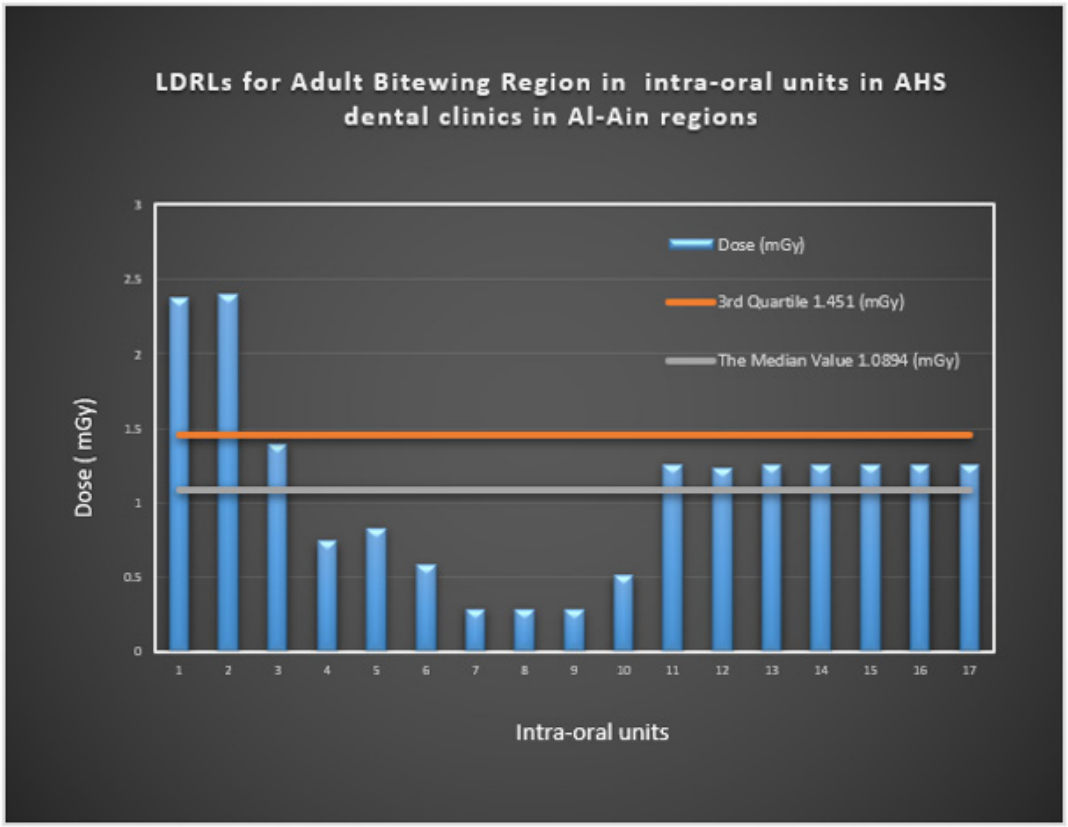
Dental Imaging	Procedure (View)	Patient Category
Intra Oral Dental	Maxillary incisor (Periapical X-rays (Anterior)	Adult and Paediatric
	Mandibular molar (Periapical X-rays Posterior)	Adult and Paediatric
	Bitewing X-rays	Adult

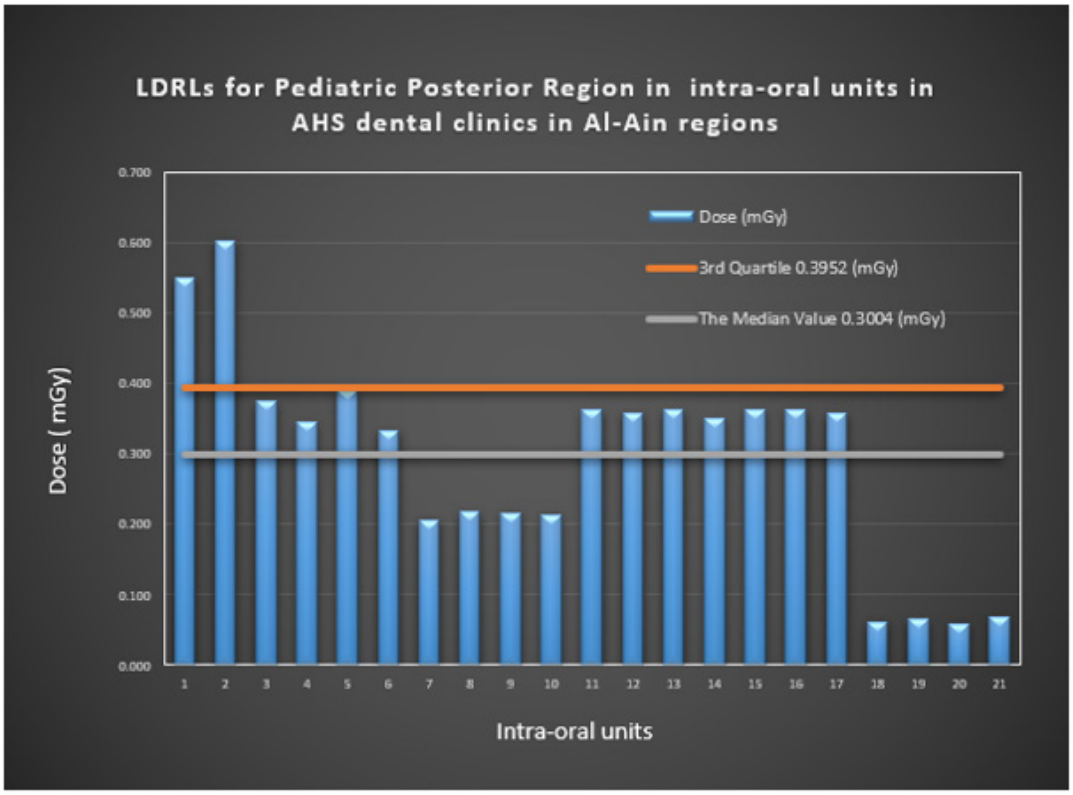
The air kerma readings for all dental units were conducted using a calibrated (Unfors RaySafe dosimeter and RaySafe X2 Solo dosimeter). The data was acquired by distributing a questionnaire to dental staff assigned to intraoral dental units. The questionnaire inquired about protocol exposure parameters, including tube kVp, mA, patient entrance dose, exposure time, and patient categories such as pediatric and adult patients and the most frequently performed examinations. This questionnaire measured the incident air kerma (Ka,i) in mGy by applying the protocol exposure parameters for adults and pediatrics according to the study's protocol. The local DRLs in intraoral procedures were estimated using the third quartile values. Before beginning DRL evaluation work, all selected X-ray units must have passed Quality Assurance (QA) examinations. Parameters such as exposure accuracy are determined during quality assurance tests. Time, operating potential, tube current linearity (mA/mAs), radiation output consistency, and irradiance are all factors to consider.

Figure 1 shows the experiment to find the patient doses in intraoral radiography. The dosimeter was placed at the exit cone of the X-ray tube, and the primary beam covered the whole sensitive area of the dosimeter. In the absence of patients, measurements were done using regular exposure parameters after situating the dosimeter ($K_{a,i}$). The dosimeter's lead backing prevents surface backscattering and provides precise ($K_{a,i}$) results [14-18].






LDRLs for Adult Bitewing Region in intra-oral units in AHS dental clinics in Al-Ain regions
Dose (mGy)
3rd Quartile 1.451 (mGy)
The Median Value 1.0894 (mGy)
Dose (mGy)
Intra-oral units


LDRLs for Pediatric Posterior Region in intra-oral units in AHS dental clinics in Al-Ain regions
Dose (mGy)
3rd Quartile 0.3952 (mGy)
The Median Value 0.3004 (mGy)
Dose (mGy)
Intra-oral units

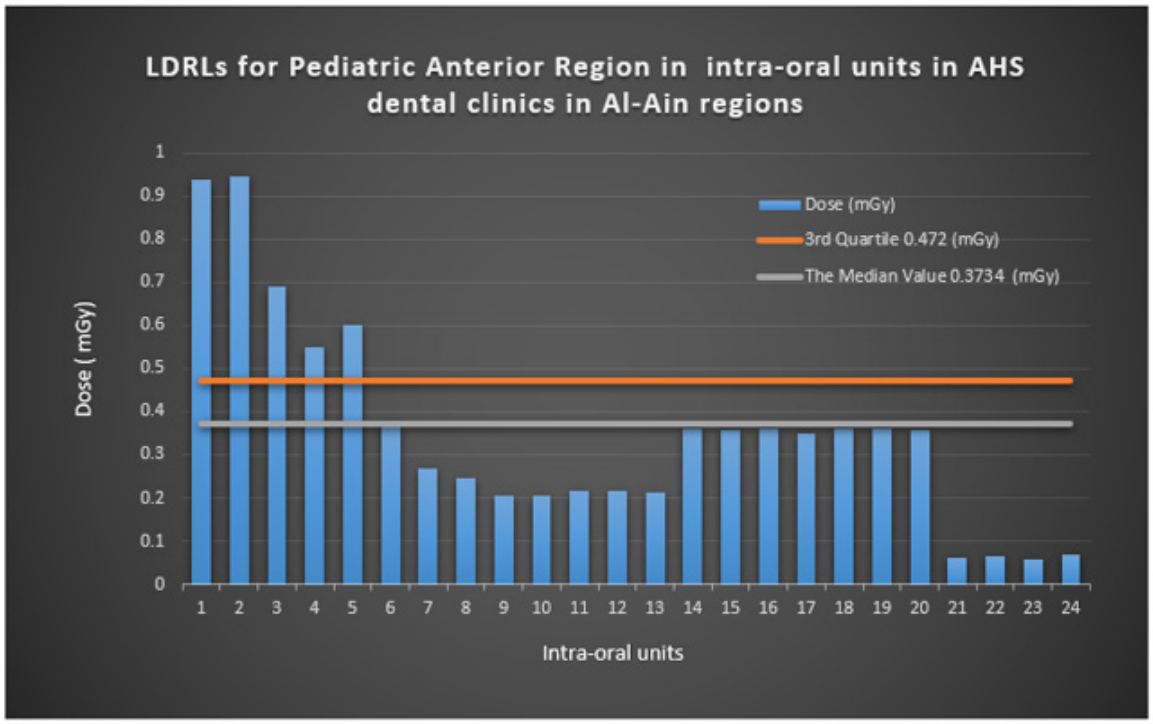


Figure 1: Proposed DRL (third quartile) and measured the dose Ka,i values of intraoral.

Results

Table 3 shows the average, third quartile, maximum, and minimum incident air kerma (Ka,i) in mGy for common dental examinations conducted at dental centers and healthcare clinics in Al-Ain. These results were collected from 21 different intraoral installations in different dental clinics in the Al-Ain region. Based on the detailed study, the proposed DRLs for 'adult maxillary incisor,' 'adult mandibular molar,' 'adult bitewing X-ray," pediatric maxillary incisor,' and pediatric mandibular molar are 0.715, 1.209, 1.451, 0.2768, and 0.3004 mGy, respectively. Adult bitewing X-rays showed the highest DRL value in this study, whereas pediatric maxillary incisors had the lowest.

Table 3: Average, third quartile, maximum, and minimum ($K_{a,i}$) for common dental exams in dental centers and healthcare clinics in Al-Ain.

Examinations	Average $K_{a,i}$ (mGy)	Third quartile $K_{a,i}$ (mGy)	Max Value $K_{a,i}$ (mGy)	Min Value $K_{a,i}$ (mGy)
Maxillary incisor (Adult Periapical X-rays (Anterior)	0.701	0.715	1.911	0.324
Maxillary molar (Adult Periapical X-rays Posterior)	0.996	1.209	3.039	0.275
Adult Bitewing X-rays	1.089	1.451	2.398	0.297
Paediatric Maxillary incisor (Periapical X-rays (Anterior)	0.2768	0.2768	0.602	0.0586
Paediatric mandibular molar (Periapical X-rays Posterior)	0.3004	0.3952	0.603	0.0586

Discussion

Table 4: Ave Comparison of AHS LDRLs with other countries.

Examinations	Japan [15]	India [14]	Kosovo [16]	Cyprus [17]	UK [18]	Western Australia [19]	This study
Maxillary incisor (Adult Periapical X-rays (Anterior)	1.93	-	-	3.68	-	-	0.715
Mandibular molar (Adult Periapical X-rays Posterior)	1.51	-	-	4.75	1.7	-	1.209
Adult Bitewing X-rays	1.2	1.5	1.8	-	1.2	2	1.451

Paediatric mandibular molar (Periapical X-rays Posterior)	-	1.18	-	3.1	0.7	-	0.2768
Paediatric Maxillary incisor (Periapical X-rays (Anterior)		1.16	-	2.41	-	-	0.3952

Table 4 compares the DRLs proposed here with those of the other countries listed in the table. Our results agree with those published in other countries, but they are lower than the DRL levels suggested in the other countries mentioned, which is a good indicator that radiation safety rules are applied to the patient during imaging. The limitation of the present study is the lack of data on rejection and repeat rates in intraoral radiography. Although the radiation doses patients receive are lower after a single exposure, the cumulative dose could be larger due to repeated exposures (Figure 2).

Figure 2: Pictorial representation of incident air kerma (Ka, i) measurement and parameters sitting in intraoral units.

Conclusion

Dental DRLs were proposed for intraoral units in dental clinics in the Al-Ain region. The proposed DRLs are comparable with those of other countries and are lower than the DRL levels suggested in the other countries mentioned. Expanding our study to include different dental facilities in the Abu Dhabi region requires more intraoral, OPG, and CBCT units in our next study.

Acknowledgment

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Conflict of Interest

The author declares that they have no conflicts of interest.

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