CRCPD Publication E-16-2

NATIONWIDE EVALUATION OF X-RAY TRENDS (NEXT)

TABULATION AND GRAPHICAL SUMMARY OF THE 2014-2015 DENTAL SURVEY

FEBRUARY 2019

Published by
Conference of Radiation Control Program Directors, Inc.
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NATIONWIDE EVALUATION OF X-RAY TRENDS (NEXT)

TABULATION AND GRAPHICAL SUMMARY OF THE 2014-2015 SURVEY OF DENTAL FACILITIES

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in association with

Conference of Radiation Control Program Directors, Inc. (CRCPD)
Healing Arts Council, H-4 Committee on
Nationwide Evaluation of X-ray Trends (NEXT)

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February 2019
Published by
Office of Executive Director
Conference of Radiation Control Program Directors, Inc.
1030 Burlington Lane, Suite 4B
Frankfort, KY 40601
www.crcpd.org

This publication was supported in part by grant number FDA-U-006519 through a cooperative agreement with the U.S. Food and Drug Administration (FDA). This document was prepared by FDA staff in association with a working group of the Conference of Radiation Control Program Directors, Inc., (CRCPD) and accepted by the CRCPD Board of Directors for publication.

FOREWORD

The Conference of Radiation Control Program Directors, Inc., (CRCPD) is an organization made up of the radiation control programs in each of the 50 states, the District of Columbia, and Puerto Rico, and of individuals, regardless of employer affiliation, with an interest in radiation protection. The primary purpose and goal of CRCPD is to assist its members in their efforts to protect the public, radiation workers, and patients from unnecessary radiation exposure. CRCPD also provides a forum for centralized communication on radiation protection matters between the states and the federal government, and between the individual states.

One method of providing assistance to the states, as well as to other interested parties, is through technical and administrative publications. Most technical publications of CRCPD are written by various committees, task forces or special working groups. Most administrative publications are written by staff of the Office of Executive Director (OED).

CRCPD's mission is "to promote consistency in addressing and resolving radiation protection issues, to encourage high standards of quality in radiation protection programs, and to provide leadership in radiation safety and education."

This publication, *Nationwide Evaluation of X-ray Trends (NEXT) Tabulation and Graphical Summary of the 2014-2015 Survey of Dental Facilities,* is the release of data for informational use.

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Chairperson, Conference of Radiation
Control Program Directors, Inc.

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PREFACE

The Conference of Radiation Control Program Directors (CRCPD) collaborates with the U.S. Food and Drug Administration (FDA) in a unique federal-state partnership to characterize the radiation doses patients receive from diagnostic x-ray procedures, and to document the state of such practice. Each one to two years, the Nationwide Evaluation of X-ray Trends (NEXT) survey program selects a particular radiological examination for study and captures radiation exposure data from a nationally representative sample of clinical facilities in the United States. NEXT was initiated in 1972 at the request of state programs that were eager for a national picture of the state of practice. Since then, NEXT has documented trends associated with:

- chest, abdomen, lumbosacral spine, dental, and pediatric chest radiography;
- fluoroscopy;
- computed tomography;
- mammography; and
- cardiac catherization

The CRCPD publishes statistical summaries of each survey. They can be accessed at https://www.crcpd.org/page/NEXT. Further information on NEXT is available at https://www.fda.gov/radiation-emittingproducts/radiationsafety/nationwideevaluationofx-raytrendsnext/default.htm.

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ACKNOWLEDGMENTS

The NEXT committee is grateful to the continued support from the American College of Radiology (ACR). Their support contributed substantially to the success of this survey. The committee also thanks the staff at the FDA Winchester Engineering Analytical Center (WEAC) including James Cherniak, who hosted and coordinated the web-based training at their facility. Finally, the committee acknowledges the tremendous technological coordination and support from Bruce Hirschler (CRCPD staff) during the training webinar. The Conference especially thanks the participating state radiation control program personnel who conducted the many site visits to gather survey data. Without their participation this survey would not have been possible.

CONTENTS

ABSTRACT

Spelic, David, U.S. Federal Food and Drug Administration; Conference of Radiation Control Program Directors (CRCPD) H-4 Committee on Nationwide Evaluation of X-ray Trends. *Nationwide Evaluation of X-ray Trends (NEXT) Tabulation and Graphical Summary of 2014-2015 Survey of Dental Facilities,* CRCPD Publication #E-19-2, February 2019, pp. 124.

This document presents the 2014-2015 Survey of Dental Facilities survey data. The tables and graphs are a summary of the data collected as part of the Nationwide Evaluation of X-ray Trends program.

ACRONYMS AND ABBREVIATIONS

AAPM	American Association of Physicists in Medicine
ACR	American College of Radiology
CBCT	Cone-beam computed tomography
CDRH	Center for Devices and Radiological Health
CR	Computed Radiology
CRCPD	Conference of Radiation Control Program Directors
DAP	Dose-area product, also known as air kerma-area product
DR	Digital Radiography
HVL	Half-value layer
I/O	Intraoral
NEXT	Nationwide Evaluation of X-ray Trends
FDA	U.S. Food and Drug Administration

INTRODUCTION

The Nationwide Evaluation of X-ray Trends (NEXT) program is a long-running collaboration between the Food and Drug Administration (FDA) and the Conference of Radiation Control Program Directors (CRCPD) to document the state of radiological practice in United States of America (USA) by conducting periodic surveys of the clinical imaging community. An x-ray modality/exam is identified for survey, and data are gathered to document the state of practice regarding indicators for patient dose, image quality, and related data elements to characterize the general x-ray practice. Past NEXT surveys include Cardiac Catheterization Fluoroscopy (2008), Computed Tomography (2005-2006) and Upper GI Fluoroscopy (2003), among others. Data summary reports from past NEXT surveys can be found on the CRCPD website at https://www.crcpd.org/page/NEXT.

Dental x-ray examination is one of the most common radiographic procedures in the USA; however, there is little published information on the radiological aspect of the dental practice. This lack of information motivated the NEXT H-4 Committee to plan and conduct a nationwide dental survey.

The NEXT survey program had conducted previous surveys of dental radiography in 1993 and 1999, capturing data regarding routine bitewing exams, and panoramic and cephalometric imaging. The NEXT Committee decided to initiate a new national survey of dental practice in 2014 based on several factors:

- The last NEXT survey of dental practice was conducted in 1999, and the NEXT Committee felt that an updated national survey of dental practice would be of great interest to the medical and dental community.

- Very few dental offices used digital x-ray systems in 1999. It was estimated that a new dental survey could capture detailed information on digital radiology and demonstrate how this technology changed dental practice.

- Little information was collected on pediatric examinations as part of the 1999 Dental NEXT survey. Given the increased concern regarding radiation dose in diagnostic x-ray examinations of pediatric patients, it was decided to survey this aspect of dental practice in detail.

- New x-ray technologies have recently emerged in diagnostic dentistry, such as Cone-Beam CT (CBCT) systems and handheld x-ray units. The 2014-2015 NEXT survey would include data collection on such novel dental x-ray systems.

SURVEY SCOPE AND STRUCTURE

The survey consisted of two levels of data collection:

- Facility-level data regarding total patient visit volumes, imaging equipment inventories including the use of digital-based technologies, and new patient imaging practices.

- Specifically, for intraoral (I/O) x-ray units, the surveyor made x-ray measurements of kVp, HVL, and exposure values to infer patient entrance air kerma. Measurements were made for x-ray settings routinely used for adult and pediatric exams.

The survey protocol included specific procedures for the survey of I/O, panoramic, and CBCT equipment. For the I/O survey component comprehensive data were gathered regarding the type of imaging technology (film/digital) used, and the use of newer handheld I/O x-ray equipment.

The protocol underwent pilot testing by NEXT committee members and also underwent a review by National Council on Radiation Protection and Measurements (NCRP) Scientific Committee 4-5 (Radiation Protection in Dentistry) for input on aspects of the survey that focus on clinical practice.

SURVEY SITE SELECTION

For a given NEXT survey, a sample set of clinical sites for the survey is derived from available data sources, such as state radiological health listings of x-ray equipment registrants. However, this is a laborious effort, and because most states already routinely visit dental facilities for state-level inspections, it was decided to allow the states to survey dental sites due for their state inspection. This also eliminated the extensive travel that many state program personnel had to undergo to survey randomly selected sites. States were given instructions regarding the proper selection of sites, such as those already scheduled for inspection, and were instructed to avoid selecting sites for survey based on their inspectional history. Distribution of the total target sample size of 300 sites among the participating state programs was determined using the most recent population data available from the U.S. Census Bureau. Each

state was provided a sample size based on its relative population. Although the NEXT surveyors made the final choice of dental clinics to be surveyed, they were instructed to give priority to sites that were equipped with CBCT systems in order to increase the sample size of sites with these imaging systems. By the conclusion of the survey, 199 sites had been surveyed in 25 states shown in Table 1. Clinical sites were surveyed between September 2014 and March 2015.

Table 1. State Radiological Health Programs That Conducted Clinical Site Visits.

Alabama	Louisiana	Nebraska
Arkansas	Massachusetts	New Hampshire
California	Maryland	New Jersey
Hawaii	Michigan	Ohio
Idaho	Minnesota	Oregon
Illinois	Missouri	Pennsylvania
Kansas	Mississippi	South Carolina
Kentucky	North Carolina	Tennessee
		Texas

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SURVEY COMPONENTS

Surveyors recorded various survey data on a Microsoft Excel worksheet. That survey worksheet consists of four components:

1. A section dedicated to the general facility data

   Data were collected on the type of x-ray units present, facility workload and exam type (adult/pediatrics), information on film processing, and Quality Control (Q/C) procedures.

2. Data collection for the stationary or handheld I/O x-ray unit

   Surveyors collected information on the x-ray unit technological characteristics, patient workload and exposure settings (adult and pediatric patients), dosimetry, image quality, kVp and HVL measurements. Only one selected I/O unit was surveyed for this section of the worksheet. For dental clinics equipped with both stationary and handheld units, only the handheld unit most frequently used was surveyed.

3. A section dedicated to the panoramic unit

   Data were collected on the panoramic unit's technical characteristics, patient workload, and x-ray exposure settings for adult and pediatric patients.

4. Survey data for the CBCT unit

   Data were collected on the CBCT unit's technical characteristics, patient workloads and x-ray exposure settings for adult and pediatric patients.

Very few dental practices are still using dedicated cephalometric equipment; therefore, unlike the previous NEXT surveys of dental radiology, this survey did not include data on cephalometric equipment.

More information on the survey form used for data collection or on the NEXT program in general can be obtained from the following sources:

- Conference of Radiation Control Program Directors
  https://www.crcpd.org/page/next

- U.S. Food and Drug Administration:
  Email: david.spelic@fda.hhs.gov or mike.hilohi@fda.hhs.gov
  Internet: https://www.fda.gov/Radiation-EmittingProducts/RadiationSafety/NationwideEvaluationofX-RayTrendsNEXT/default.htm

DATA COLLECTION

Surveyors from participating state radiation control programs conducted site visits at dental facilities already due for a state inspection. During these site visits, facility personnel were interviewed for data regarding the site's general dental practice and x-ray imaging program, such as x-ray equipment inventories, patient workloads, and types of imaging exams conducted. For the imaging modalities under survey (I/O bitewing, panoramic, and CBCT imaging), the surveyor collected typical technique factors for examination of adult and pediatric patients, and related data items. Specifically, for the I/O x-ray unit, the surveyor used the NEXT dental phantom to evaluate high contrast detail performance (reported as a count of the number of copper mesh patterns that are visible) under routine imaging conditions.

Photograph courtesy of FDA labs.

Figure 1. The NEXT dental image quality phantom.

This phantom was used first during the 1999 dental survey. A total of four copper mesh objects are imbedded in the phantom.

The surveyor also made measurements of x-ray output characteristics of the I/O unit, including kVp, HVL, and measurement of patient-representative entrance air kerma.

For selected data elements the survey differentiated between small children with primary dentition (up to approximately 12 years of age), and older children with permanent dentition (of approximate age 12 years and older).[1]

[1] The values for age at primary/transitional/permanent dentition are approximate, and are based on published dentition charts available from the American Dental Association at: https://www.mouthhealthy.org/en/az-topics/e/eruption-charts

SUMMARY OF FINDINGS

The results of this survey characterize aspects of the state of dental radiological practice in the USA at the time of data collection (years 2014 - 2015). The following results represent responses from 199 dental practices reported from 25 states distributed across the USA.

INTRAORAL RADIOGRAPHY

The NEXT survey captured a number of indicators regarding the practice of general I/O x-ray imaging including the type of imaging equipment, volumes of exams for adult and pediatric patients, and patient dose indices. The following tables summarize selected findings. The annual number of exams is based on the survey data, extrapolated to the USA population.

Table 2. Intraoral Imaging in the United States.

Radiographic Techniques	Percent
Percent of surveyed sites using digital-based technology	86
Percent of sites using hand-held intraoral x-ray units	16
Percent of surveyed sites using the same intraoral radiographic technique for all patients	30.3

Table 3. Average Intraoral Exam, Air Kerma at Skin Entrance.

Adults	1.0 mGy
Children[a]	0.7 mGy

[a1]"Children" includes young children with primary dentition and older children/adolescents.

Table 4. Total Annual Number of Intraoral Exams (millions).

All intraoral exams	296
Children[a]	86

[a1]"Children" includes young children with primary dentition and older children/adolescents.

During the previous NEXT survey of dental facilities conducted in 1999, no dental site was found to be using digital-based x-ray imaging. The present survey documents that digital intraoral imaging is now the predominant technology. Of note, the survey found that for those sites still using film, D-speed was still the film of choice.

The patient x-ray air kerma decreased since the previous dental NEXT survey. In 1999 the average patient I/O entrance skin air kerma was 1.6 mGy, compared with 1.0 mGy in this survey. Likely the notable decrease is a result of the predominant use (85.6% of surveyed sites) of digital sensors.

While the previous survey did not document the specific practice of pediatric x-ray imaging, the current survey found that the majority of surveyed sites use dedicated radiographic techniques for these younger patients. This finding is reflected in the lower average value for patient entrance exposure for pediatric patients as compared with that for adult patients.

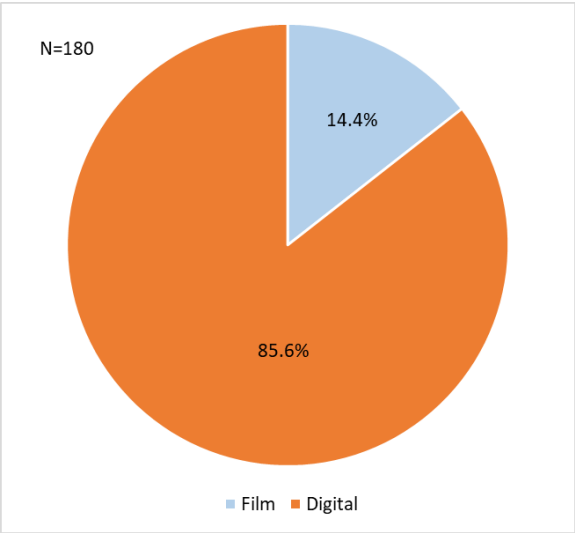


Figure 2. Types of intraoral image receptors. Percent of film and digital intraoral image receptors, with digital including computed radiography (CR) and digital radiography (DR).

PANORAMIC AND CONE-BEAM COMPUTED TOMOGRAPHY IMAGING

As with I/O imaging, the survey found a majority of sites (43/52) to be using digital-based panoramic equipment. Weekly exam volume for these units tended to be low (less than 10 exams per week on average). A third of surveyed units were operated in a hallway or alcove as opposed to a dedicated room.

At the time this report was prepared there were no known data sources that provided reliable estimates for the number of panoramic systems currently in use in the USA to permit estimation of an annual exam workload in the USA. Panoramic technique factors are presented in this report; however data for inferring patient x-ray exposure were not collected in part because of the complex scanning geometry of this imaging modality.

The present survey captured data regarding the use of newer CBCT equipment in dental practice. Such systems typically offer 3D-based visualization and other sophisticated software tools, and many utilize newer reconstruction methods such as iterative reconstruction. The survey found that dental sites with a focus on the practice of oral surgery were as likely to use CBCT (44%) as general practice sites (48%); orthodontic practices seldom provided this mode of imaging (8%).

Data gathered from state radiological health programs permitted inference of the annual number of CBCT exams conducted in the USA at the time of survey. The estimate is based on numbers of sites with registered CBCT equipment in the state and extrapolation of these counts in 11 states to the entire USA. based on the relative USA population of these states. It is estimated that there were approximately 5.2 million CBCT exams conducted annually in dental-based practices in the USA at the time of the present survey. Of these, approximately 1.5 million were conducted on pediatric patients.

Table 5. Panoramic Imaging Average Weekly Number of Exams.

Patient	Average Weekly Number of Exams
Adults	9
Older children with permanent dentition	3
Young children with primary/transitional dentition	2

Table 6. Cone-Beam Computed Tomography (CBCT).

Estimated number of units in clinical practices in the United States	7340
Estimated number of exams (thousands) - Adults	3708
Estimated number of exams (thousands) - Children [a]	1468

[a] "Children" includes young children with primary dentition and older children/adolescents.

Appendices to this report include:

- Appendix A - Facility General Data
- Appendix B - Intraoral Procedures
- Appendix C – Panoramic Procedures
- Appendix D - Cone-Beam Computed Tomography Procedures

Throughout this report and the appendices, conversions between SI and conventional units may be made by using the factor 1.0 mGy = 1.0 mR x 0.00876.

APPENDIX A – FACILITY GENERAL DATA

Table A-1. Types of Dental Facilities Surveyed.

Type of Facility	Percent
General Dentistry	80.0
Orthodontic	9.5
Endodontic	3.0
Oral Surgery	7.5

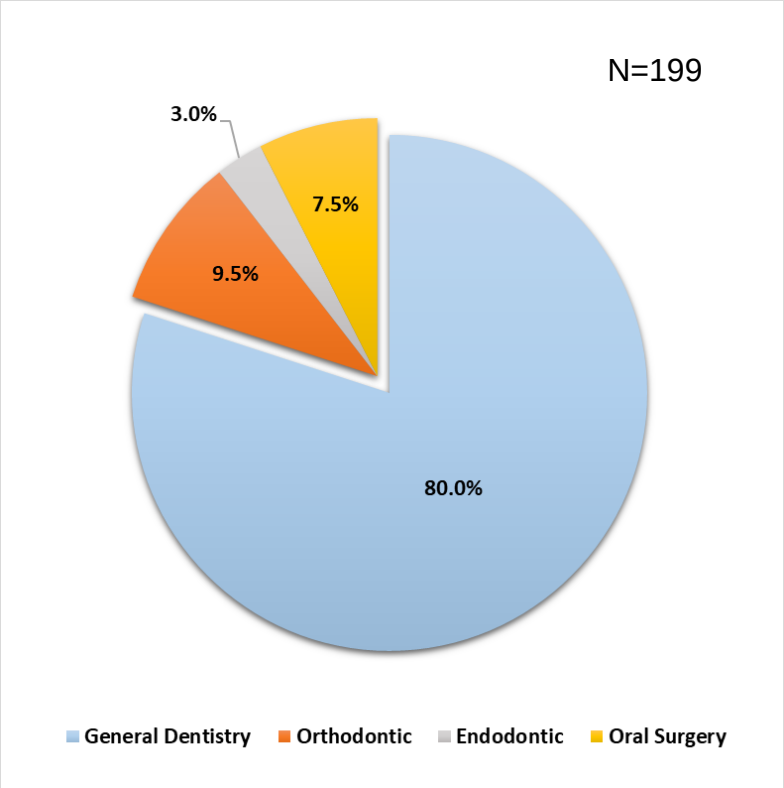


Figure A-1. Percent of general, orthodontic, endodontic and oral surgery dental facilities surveyed.

Table A-2. Number of Patient Visits per Week – Descriptive Statistics.

Type of Patient	N	Mean	Std. Dev.	Min	25%	Median	75%	Max
Pediatric Patients (Under 18 Years)	191	24.0	47.4	0	2	10	25	500
Adult Patients	195	64.8	61.2	0	25	50	81	500

Table A-3. - Number of Patient Visits per Week Frequency Distribution.

Type of Patient	N	0-25	26-50	51-75	76-100	101-125	126-150	151+
Pediatric Patients (Under 18 Years)	191	145	30	0	9	2	0	5
Adult Patients	195	51	56	30	26	9	9	14

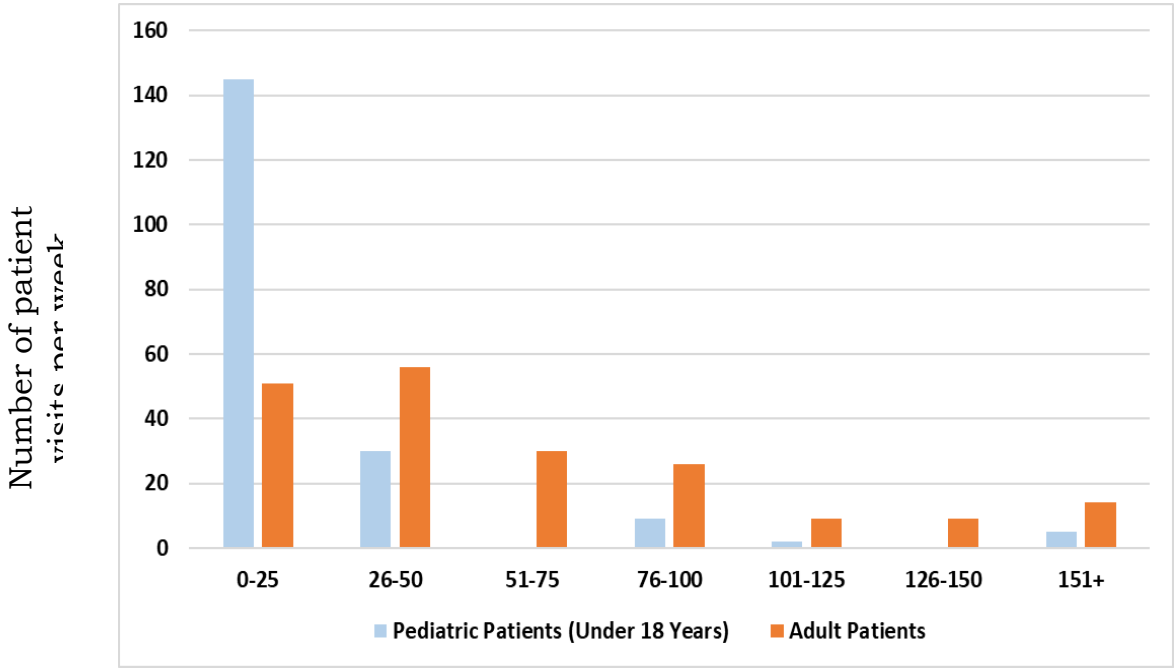


Figure A-2. Number of pediatric and adult patient visits per week.

Table A-4. Type of Imaging Performed on New Patients – Young Children.

Young Children with primary/transitional dentition	Full Mouth	Bitewing	Selected Periapicals	Lateral or PA Ceph	Panoramic	CBCT
Number of Facilities	19	121	84	14	74	11
Percent Imaging Type Performed[a]	9.5	60.8	42.2	7.0	37.2	5.5

[a]Percents are reported with respect to the total sample size of 199 surveyed facilities. Facilities were allowed to select more than one category for type of imaging performed.

Table A-5. Type of Imaging Performed on New Patients Adolescents/Adults.

Adolescents/Adults	Full Mouth	Bitewing	Selected Periapicals	Lateral or PA Ceph	Panoramic	CBCT
Number of Facilities	122	132	105	22	106	22
Percent Imaging Type Performed[a]	61.3	66.3	52.8	11.1	53.3	11.1

[a]Percents are reported with respect to the total sample size of 199 surveyed facilities. Facilities were allowed to select more than one category for type of imaging performed.

Table A-6. Image Processing Types.

Types of Imaging Processing	Number	Percent
Process Films with Darkroom	27	14.1
Daylight Film Processor	7	3.6
All Digital	158	82.3

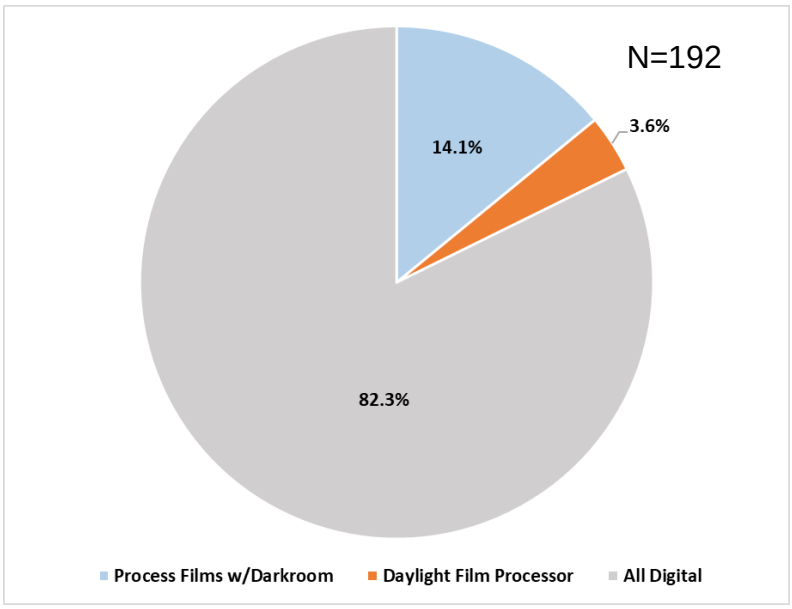


Figure A-3. Percent of image processing types.

Table A-7. Number and Types of X-ray Units at the Dental Facility - Descriptive Statistics.

Type	Mean	Std. Dev.	Min	25%	Median	75%	Max
Stationary I/O Units	2.7	1.95	0	1	3	4	10
Panoramic Units	0.61	0.5	0	0	1	1	2
CBCT Units	0.14	0.36	0	0	0	0	2
Handheld Units	0.22	0.66	0	0	0	0	6

Table A-8. Number and Percent of Facilities Based on Type of X-ray Unit.

Type of Unit	Number of Facilities with This Type of Unit	Percent of Facilities with This Type of Unit
Stationary I/O Units	149	74.9
Panoramic Units	115	57.8
CBCT Units	28	14.1
Handheld Units	32	16.1

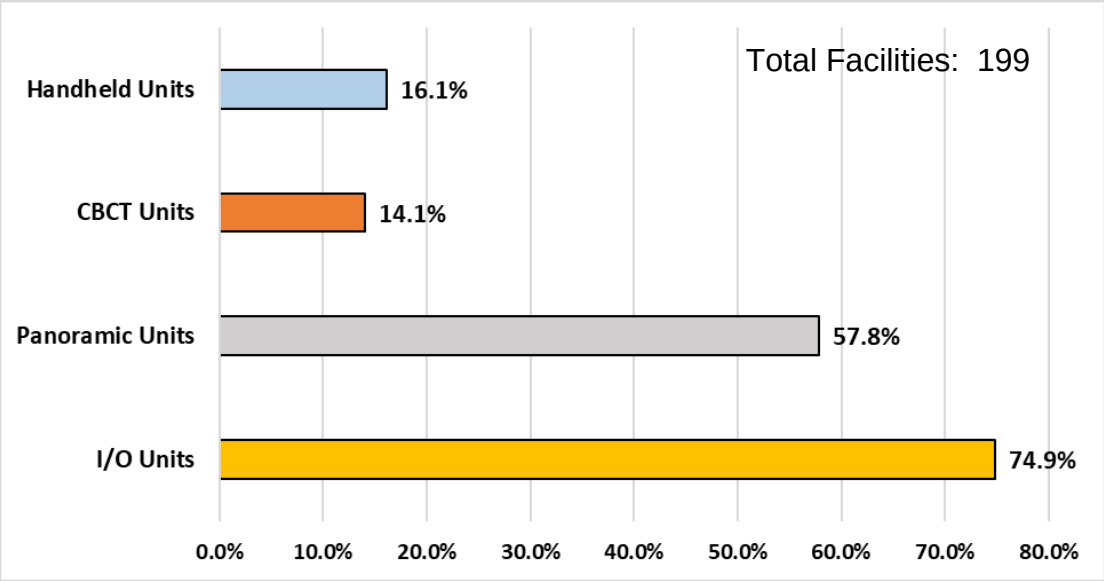


Figure A-4. Percent of dental facilities with specified type of x-ray unit.

Table A-9. Type of Facility with a Cone-Beam Computed Tomography Unit.

Type of Facility	Number of This Type of Facility	Percent of This Type of Facility
General Dentistry	12	46.2
Orthodontic	2	7.7
Endodontic	2	7.7
Oral Surgery	9	34.6
Other (Periodontic, etc.)	1	3.8

Total Facilities: 26

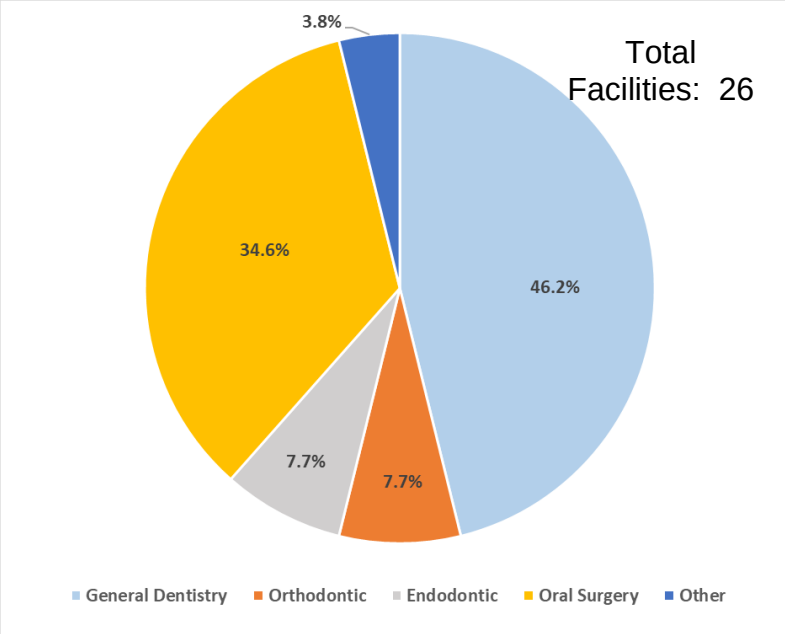


Figure A-5. Percent of types of facility with a cone-beam computed tomography unit.

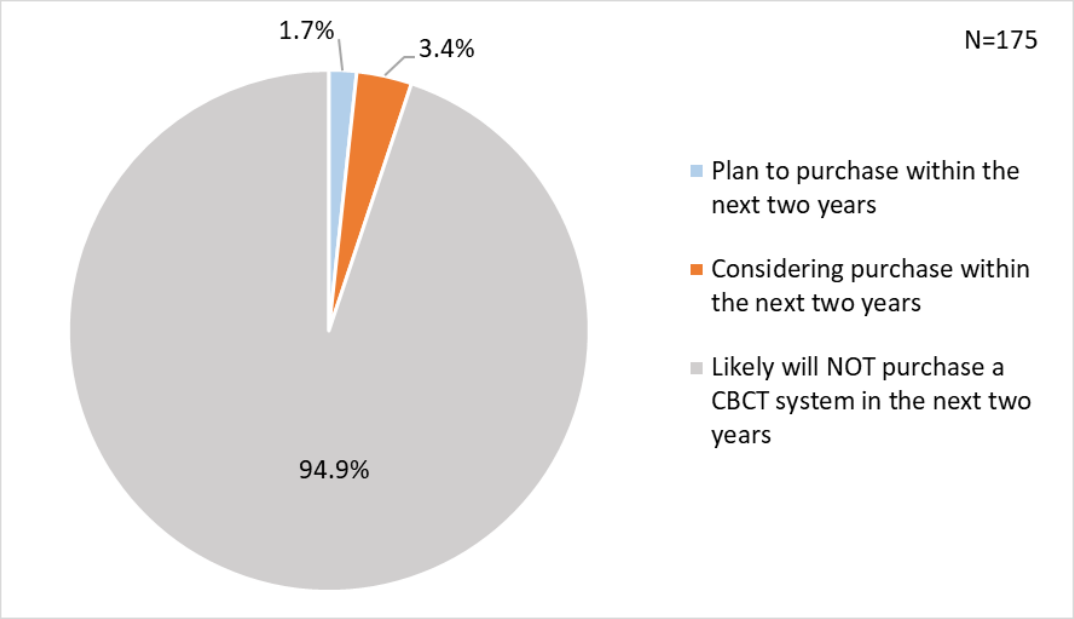


Figure A-6. Percent of facilities planning to acquire a CBCT unit within the next two years.

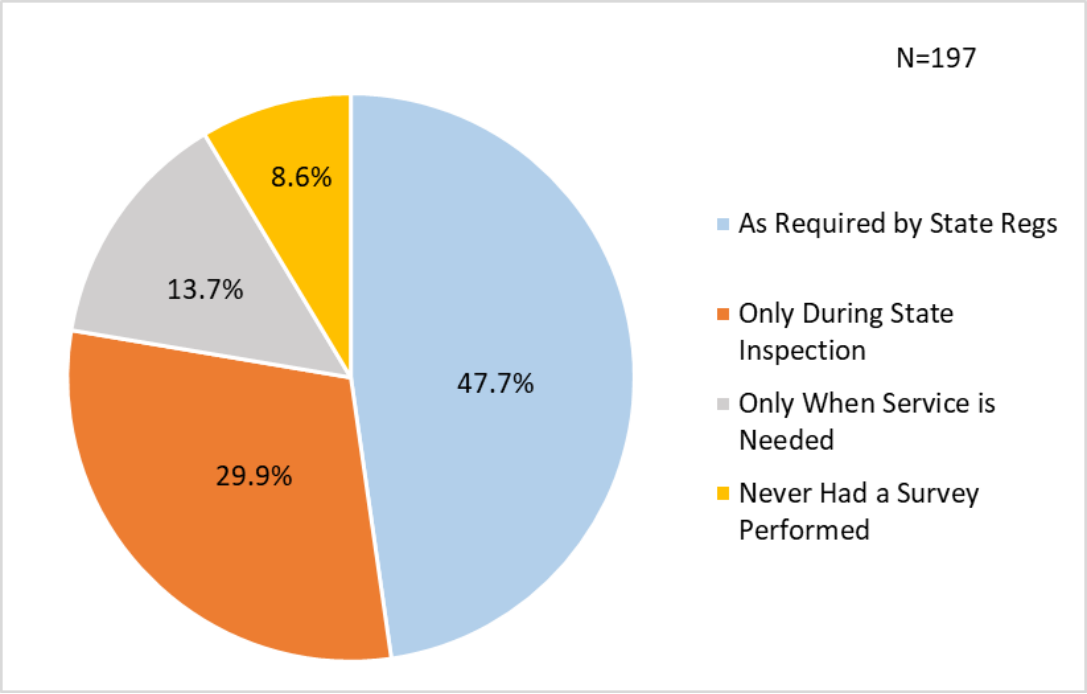
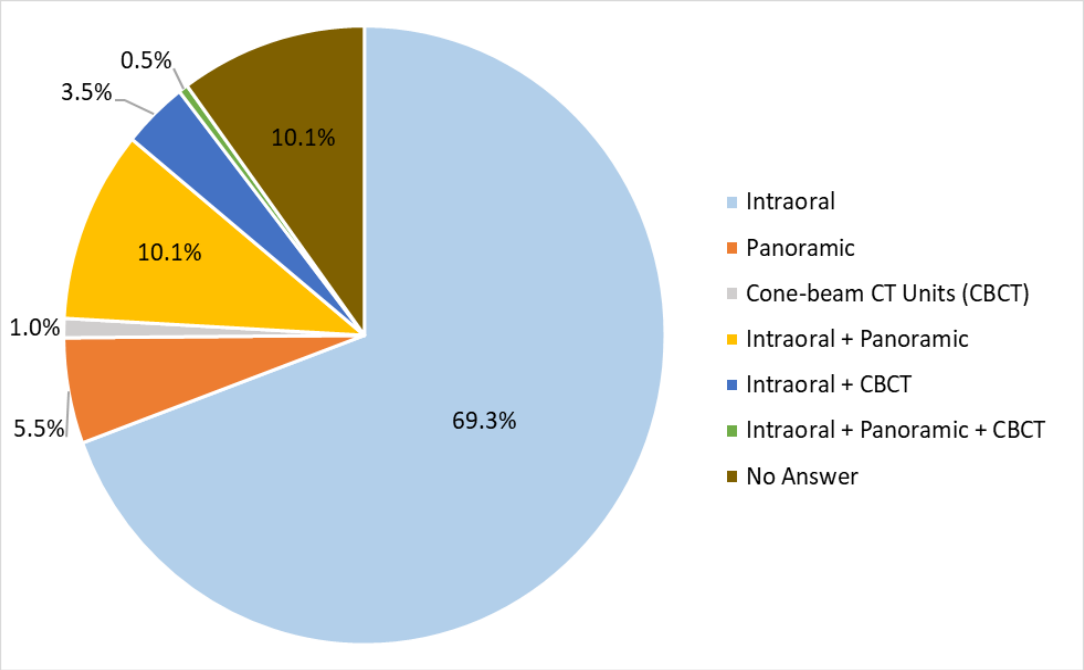


Figure A-7. Frequency of quality control survey performed on x-ray equipment by percent.

Table A-10. X-ray Equipment for which Patient Dose Indices Were Measured.

Types of Equipment	Number	Percent
Intraoral	138	69.3
Panoramic	11	5.5
Cone-beam CT Units (CBCT)	2	1.0
Intraoral + Panoramic	20	10.1
Intraoral + CBCT	7	3.5
Intraoral + Panoramic + CBCT	1	0.5
No Answer	20	10.1

Total Facilities: 199



Total Facilities: 199

Figure A-8. Percent of types of x-ray equipment for which patient dose indices were measured.

APPENDIX B - INTRAORAL PROCEDURES

Table B-1. Number of Intraoral X-ray Exams per Week at Surveyed Facility (Combined Stationary and Handheld Units).

Exams per Week	Number	Cumulative Number	Percent	Cumulative Percent
0 – 100	143	143	79.4	79.4
101-200	21	164	11.7	91.1
201-300	6	170	3.3	94.4
301-400	7	177	3.9	98.3
401+	3	180	1.7	100.0

Table B-2. Number of Intraoral X-ray Exams per Week at Surveyed Facility (Combined Stationary and Handheld Units) - Descriptive Statistics.

Exams per Week	N	Mean	Std. Dev.	Min	25%	Median	75%	Max.
	180	81.8	103	0	25	49	90	600

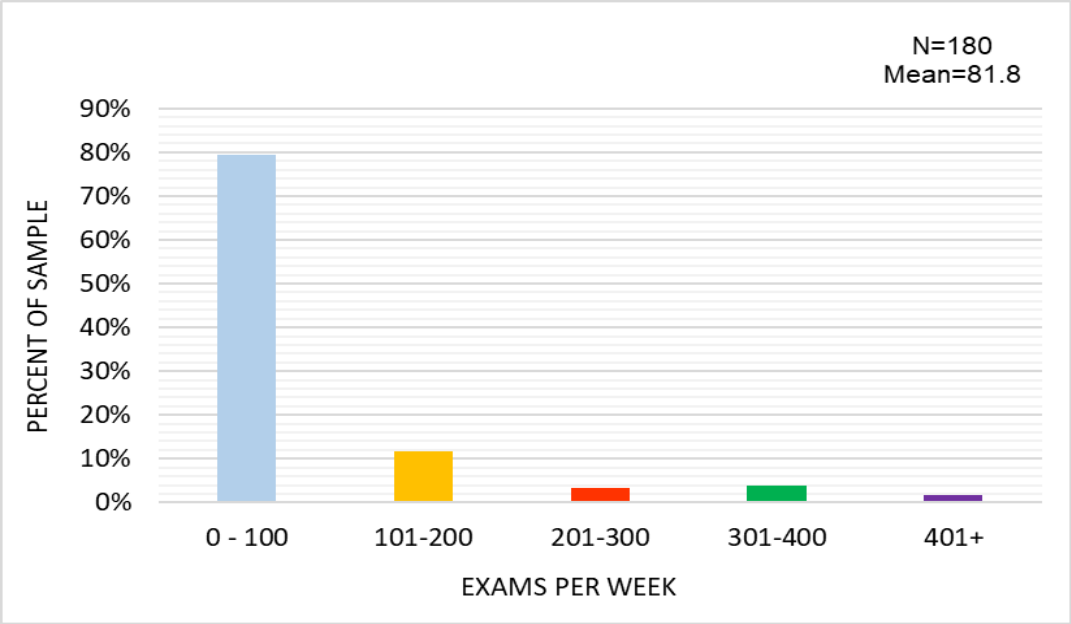


Figure B-1. Number and percent of intraoral x-ray exams per week at surveyed facility (combined stationary and handheld units).

Table B-3. Primary Type of Intraoral Unit Utilized by Facilities (Surveyed Unit).

Primary Type	Stationary	Handheld	Not Indicated	Percent Stationary	Percent Handheld	Percent Not Indicated
	149	32	18	74.9	16.1	9.0

Total Facilities: 199

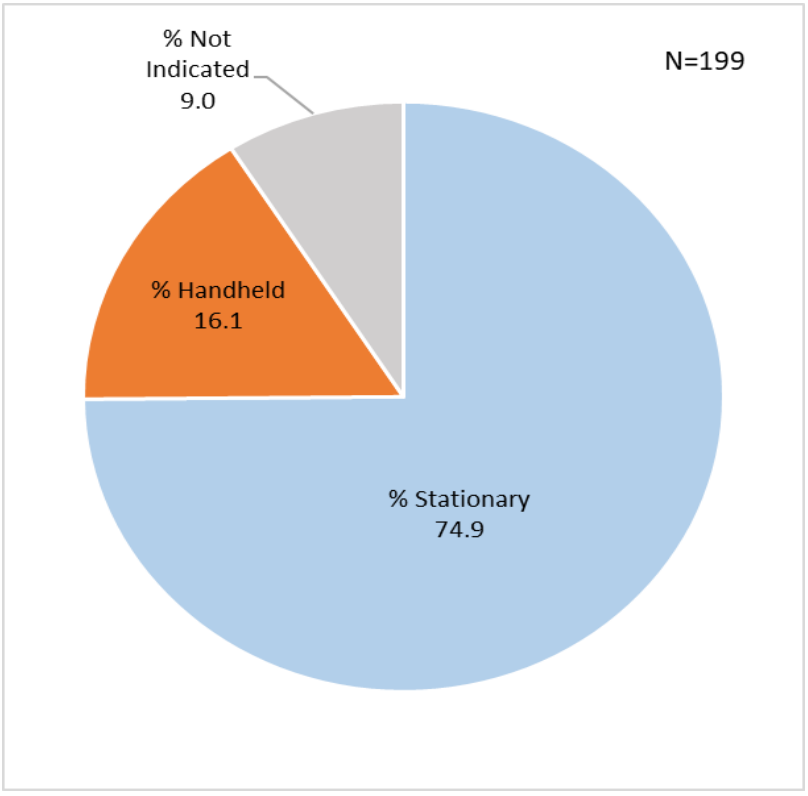


Figure B-2. Percent and number of primary types of intraoral unit utilized by facilities (surveyed unit).

Table B-4. Date of Manufacture of Intraoral Unit Utilized by Facilities (Surveyed Unit – Stationary).

Date of Manufacture Stationary	1989 or earlier	1990 - 1999	2000 - 2009	2010 - 2014
Number of Units	13	30	69	35
Percent of Units	8.8	20.4	46.9	23.8

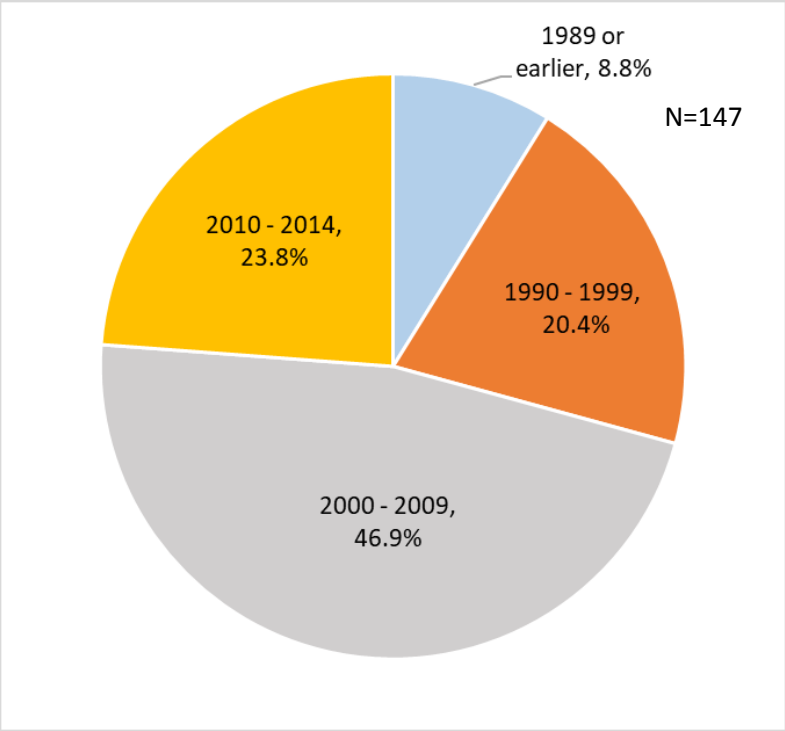


Figure B-3. Percent of intraoral units utilized by facilities by date of manufacture (surveyed unit – stationary).

Table B-5. Date of Manufacture of Intraoral Unit Utilized by Facilities (Surveyed Unit – Handheld).

Date of Manufacture Handheld	Pre-2010	2010+
Number of Units	5	26
Percent of Units	16.1	83.9

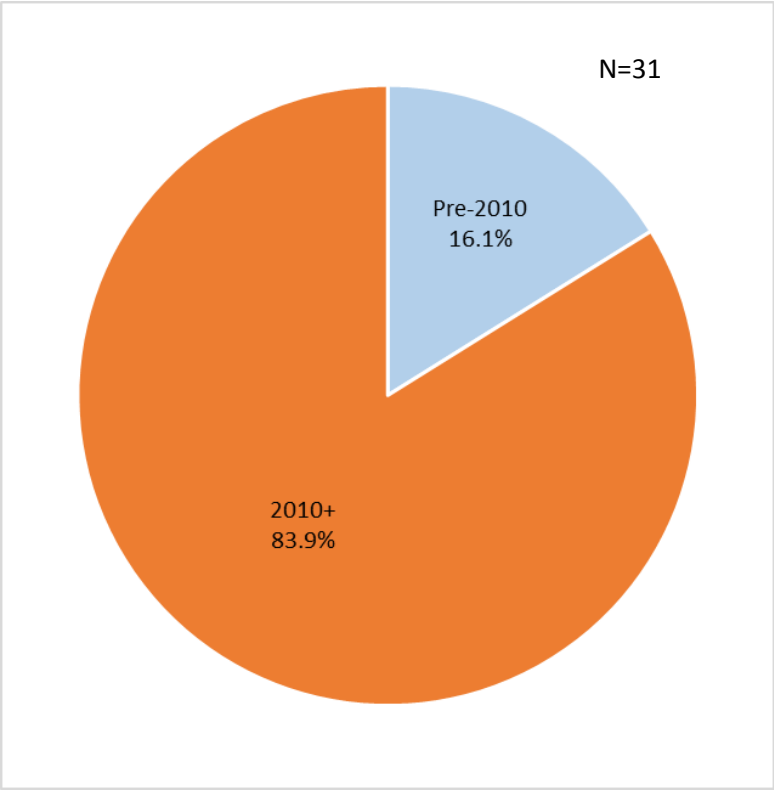


Figure B-4. Percent of intraoral units utilized at facilities by date of manufacture (surveyed unit – handheld).

Table B-6. Intraoral Image Receptor Type - Film vs. Digital (CR and DR).

Receptor Types	Film	Digital	Percent Film	Percent Digital
	26	154	14.4	85.6

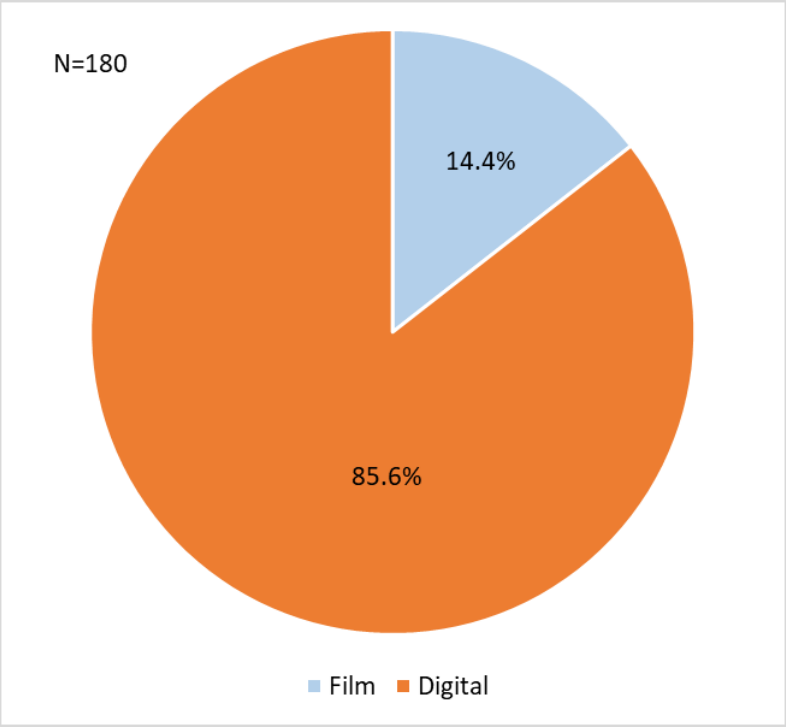


Figure B-5. Percent of intraoral image receptor types - film vs. digital (CR and DR).

Table B-7. Intraoral Image Receptor Type - CR vs. DR.

Receptor Type	CR	DR	Percent CR	Percent DR
	25	97	20.5	79.5

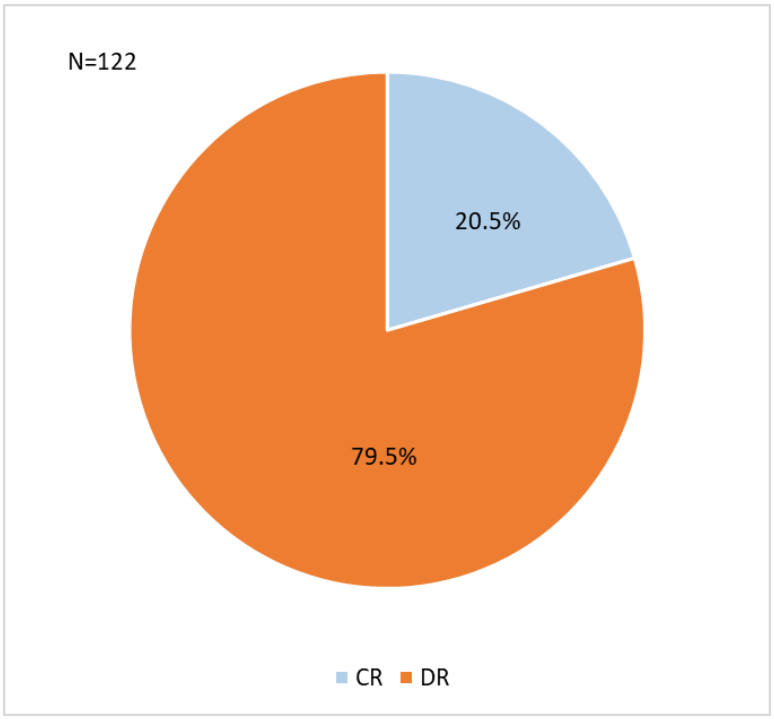


Figure B-6. Percent of intraoral image receptor types, CR vs. DR.

Table B-8. Film Speed for Film-based Stationary Intraoral Units.

Film Speed	"B"	"D"	"E"	"F"
Number of Units	1	19	2	8
Percent of Units per Film Speed	3.3	63.3	6.7	26.7

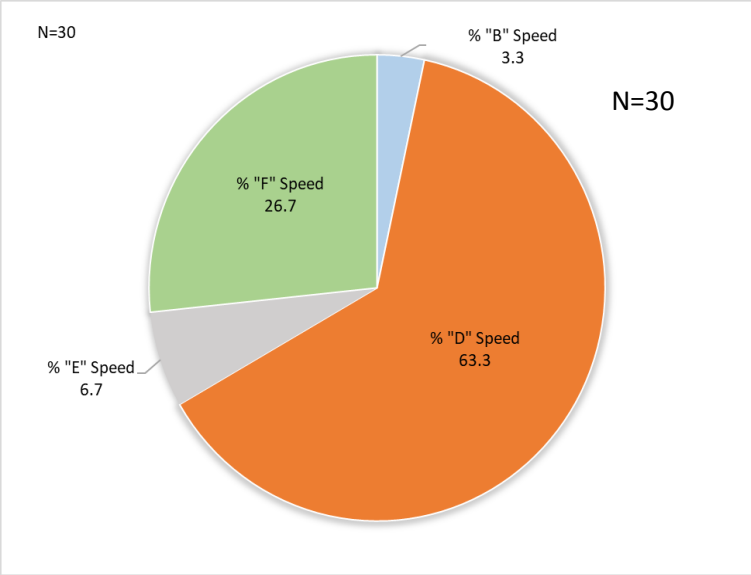


Figure B-7. Percent of film speeds for film-based stationary intraoral units.

Table B-9. Number of Intraoral X-ray Exams per Week Conducted with Surveyed X-ray Unit for Young Children with Primary/Transitional Dentition, Children/Adolescents with Permanent Dentition, and Adults - Statistical Distribution.

Exams per Week	N	Mean	Std. Dev.	Min	25%	Median	75%	Max
Young Children with Primary/ Transitional Dentition, Surveyed Unit	135	8.7	14.8	0	1	3	10	80
Children/ Adolescents with Permanent Dentition, Surveyed Unit	148	10.4	16.4	0	2	5	10	100
Adults, Surveyed Unit	172	38.7	50	0	10	20	50	360

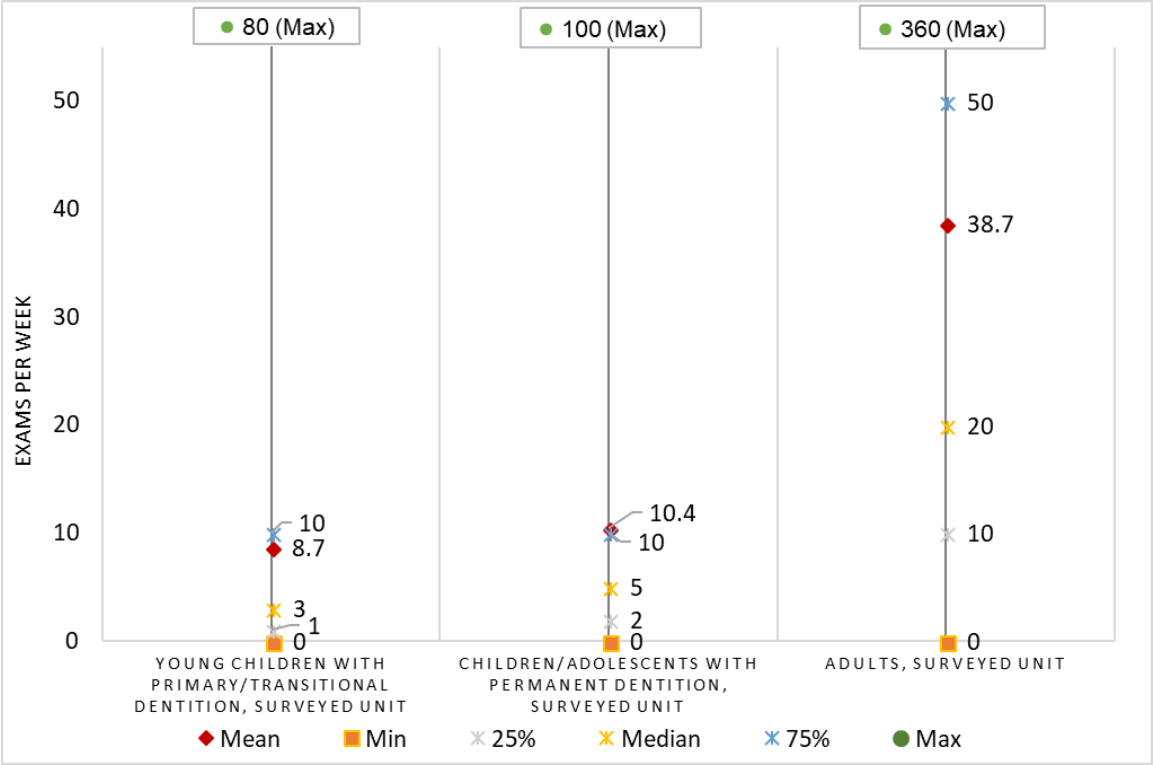


Figure B-8. Number of intraoral x-ray exams per week conducted with surveyed x-ray unit for young children with primary/transitional dentition, children/adolescents with permanent dentition, and adults.

Table B-10. Average Number of Intraoral Images per Exam Conducted with Surveyed X-ray Unit for Young Children with Primary/Transitional Dentition.

Images per Exam, Young Children with Primary/Transitional Dentition	Number	Cumulative Number	Percent	Cumulative Percent
1 Image	4	4	3.8	3.8
2 Images	65	69	61.9	65.7
3 Images	6	75	5.7	71.4
4 Images	22	97	21.0	92.4
5 Images	3	100	2.9	95.2
6 Images	3	103	2.9	98.1
7+ Images	2	105	1.9	100.0

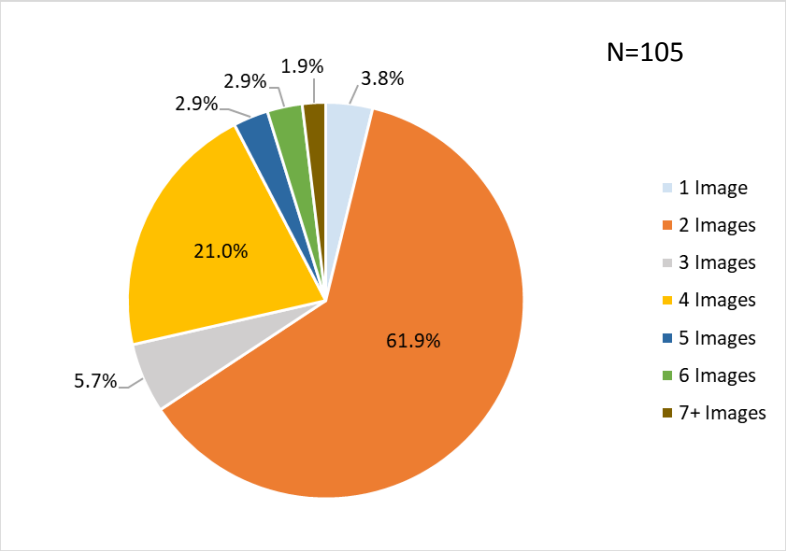


Figure B-9. Average number of intraoral images per exam conducted with surveyed x-ray unit for young children with primary/transitional dentition.

Table B-11. Average Number of Intraoral Images per Exam Conducted with Surveyed X-ray Unit for Children/Adolescents with Permanent Dentition.

Images per Exam, Older Children/Adolescents with Permanent Dentition	Number	Cumulative Number	Percent	Cumulative Percent
1 Image	13	13	10.0	10.0
2 Images	32	45	24.6	34.6
3 Images	4	49	3.1	37.7
4 Images	54	103	41.5	79.2
5 Images	5	108	3.8	83.1
6 Images	10	118	7.7	90.8
7+ Images	12	130	9.2	100.0

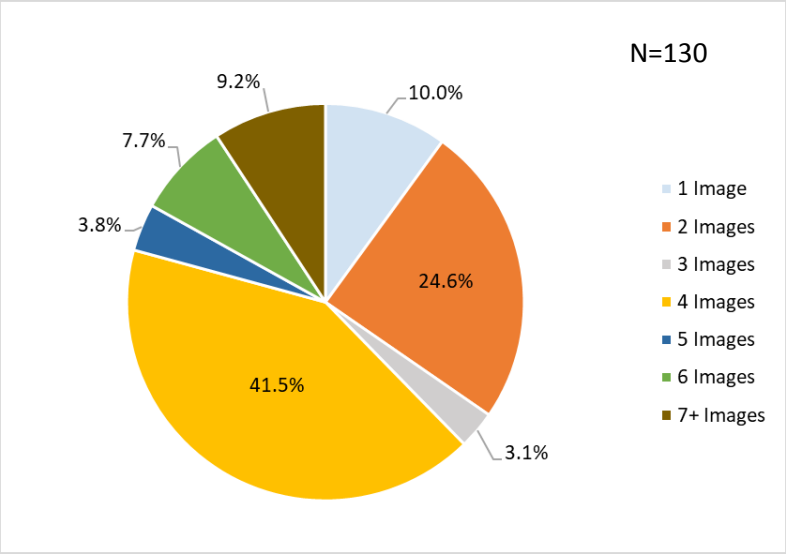


Figure B-10. Average number of intraoral images per exam conducted with surveyed x-ray unit for children/adolescents with permanent dentition.

Table B-12. Average Number of Intraoral Images per Exam Conducted with Surveyed X-ray Unit for Adults.

Images per Exam, Adults	Number	Cumulative Number	Percent	Cumulative Percent
1 Image	12	12	7.4	7.4
2 Images	19	31	11.7	19.1
3 Images	9	40	5.6	24.7
4 Images	66	106	40.7	65.4
5 Images	5	111	3.1	68.5
6 Images	19	130	11.7	80.2
7+ Images	32	162	19.8	100.0

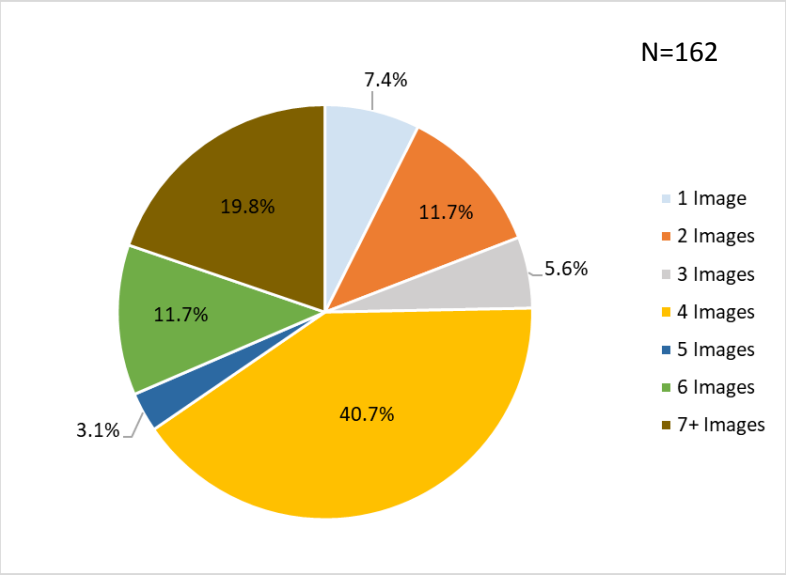


Figure B-11. Average number of intraoral images per exam conducted with surveyed x-ray unit for adults.

Table B-13. Average Number of Intraoral Images per Exam Conducted with Surveyed X-ray Unit for Young Children with Primary/Transitional Dentition, Children/Adolescents with Permanent Dentition, and Adults - Statistical Distribution.

	N	Mean	Std. Dev.	Min	25%	Median	75%	Max
I/O Images per Exam, Young Children	105	2.9	2.1	1	2	2	4	20
I/O Images per Exam, Children/Adolescents	130	4	2.9	1	2	4	4	18
I/O Images per Exam, Adults	162	5.6	4.7	1	4	4	6	19

Table B-14. Approximate Number of Retakes per Week Conducted with Surveyed X-ray Unit for Young Children with Primary/Transitional Dentition.

Retakes per Week	Number	Cumulative Number	Percent	Cumulative Percent
No Retakes	76	76	60.8	60.8
1	24	100	19.2	80.0
2	15	115	12.0	92.0
3	2	117	1.6	93.6
4	1	118	0.8	94.4
5	4	122	3.2	97.6
6+	3	125	2.4	100.0

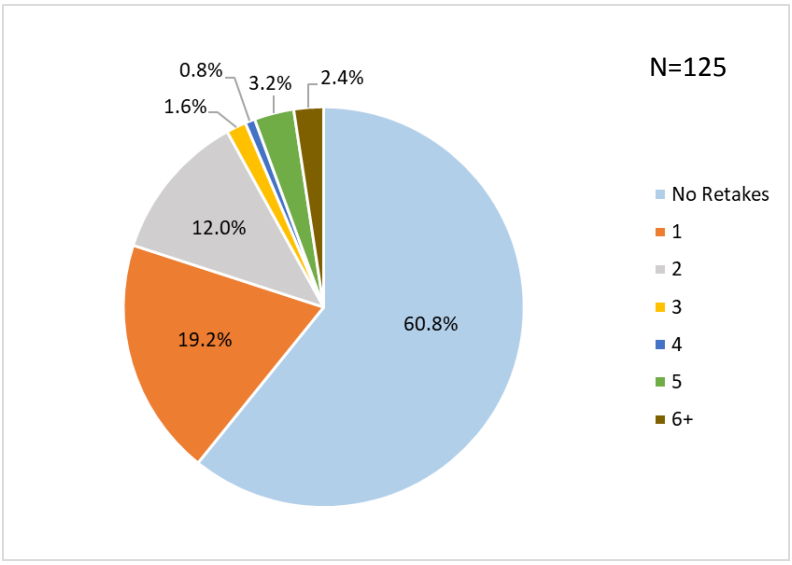


Figure B-12. Approximate number of retakes per week conducted with surveyed x-ray unit for young children with primary/transitional dentition.

Table B-15. Approximate Number of Retakes per Week Conducted with Surveyed X-ray Unit for Children/Adolescents with Permanent Dentition.

Retakes per Week	Number	Cumulative Number	Percent	Cumulative Percent
No Retakes	72	72	52.9	52.9
1	33	105	24.3	77.2
2	18	123	13.2	90.4
3	3	126	2.2	92.6
4	0	126	0.0	92.6
5	3	129	2.2	94.9
6+	7	136	5.1	100.0

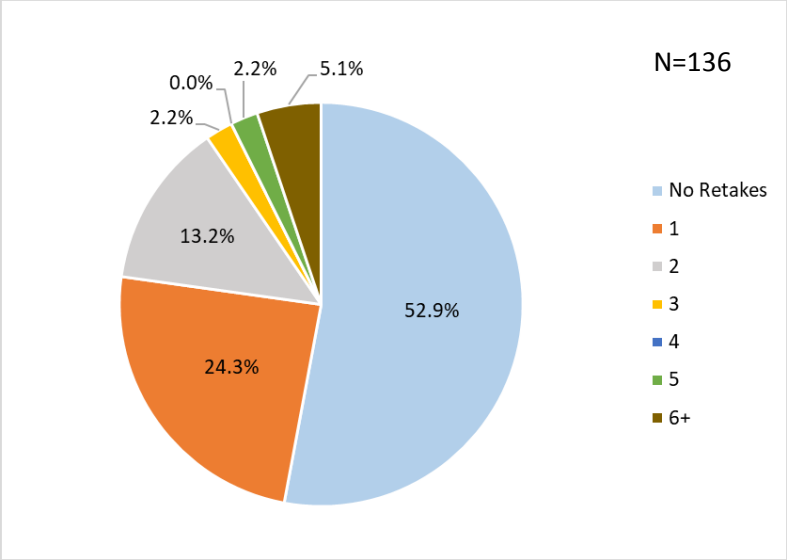


Figure B-13. Approximate number of retakes per week conducted with surveyed x-ray unit for children/adolescents with permanent dentition.

No instances of 4 retakes per week were reported, as shown as 0.0% on the chart.

Table B-16. Approximate Number of Retakes per Week Conducted with Surveyed X-ray Unit for Adults.

Retakes per Week for Adults	Number	Cumulative Number	Percent	Cumulative Percent
No Retakes	53	53	32.7	32.7
1	42	95	25.9	58.6
2	26	121	16.0	74.7
3	7	128	4.3	79.0
4	6	134	3.7	82.7
5	15	149	9.3	92.0
6+	13	162	8.0	100.0

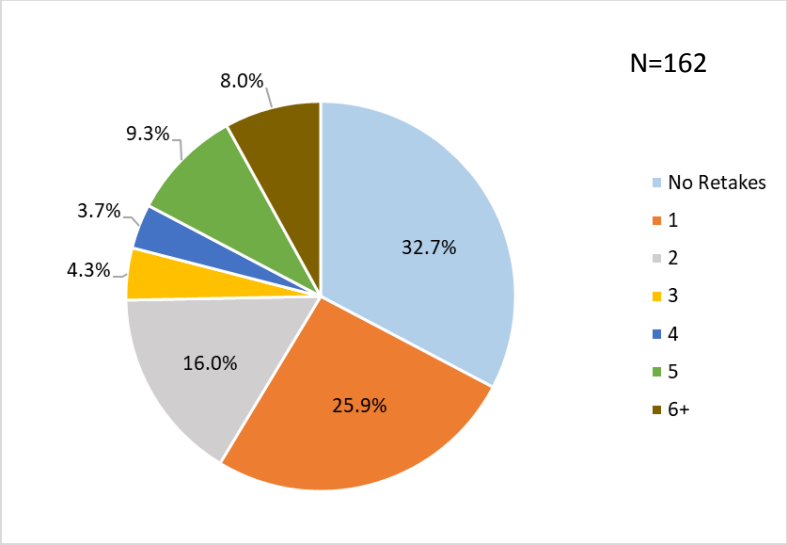


Figure B-14. Approximate number of retakes per week conducted with surveyed x-ray unit for adults.

Table B-17. Stationary Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit for Children and Adolescents/Adults – Statistical Distribution.

	N	Mean	Std. Dev.	Min	25%	Median	75%	Max
kVp - Children	122	67.1	4	60	65	70	70	70
kVp – Adolescents/Adults	148	67.3	4	55	65	70	70	70
Exp Time (msec) - Children	106	140.6	122.2	30	80	100	160	833
Exp Time (msec) - Adolescents/Adults	128	199.1	136.2	30	100	160	250	833
mA - Children	122	7.6	1.7	2.5	7	7	8	15
mA – Adolescents/Adults	147	7.6	1.7	2.5	7	7	8	15
mAs - Children	106	1.1	1.3	0.2	0.6	0.8	1.3	9
mAs – Adolescents/Adults	127	1.6	1.3	0.2	0.7	1.3	1.8	9

Table B-18. Handheld Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit for Children and Adolescents/Adults – Statistical Distribution.

	N	Mean	Std. Dev.	Min	25%	Median	75%	Max
kVp - Children	30	60.7	2.5	60	60	60	60	70
kVp – Adolescents/Adults	27	60.7	2.7	60	60	60	60	70
Exp Time (msec) - Children	30	164.5	113.2	60	100	135	170	650
Exp Time (msec) - Adolescents/Adults	27	200.9	118.1	86	120	170	267	650
mA - Children	30	2.9	1.6	2.3	2.5	2.5	2.5	10
mA – Adolescents/Adults	27	2.9	1.7	2.3	2.5	2.5	2.5	10
mAs - Children	30	0.5	0.4	0.1	0.3	0.4	0.4	2
mAs – Adolescents/Adults	27	0.6	0.5	0.2	0.4	0.4	0.7	2.7

Table B-19. Stationary Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit (kVp) for Children.

Stationary I/O Clinical X-ray Technique, kVp for Children	Number	Cumulative Number	Percent	Cumulative Percent
60 kVp	22	22	18.0	18.0
63 kVp	6	28	4.9	23.0
65 kVp	15	43	12.3	35.2
70 kVp	76	119	62.3	97.5
Other	3	122	2.5	100.0

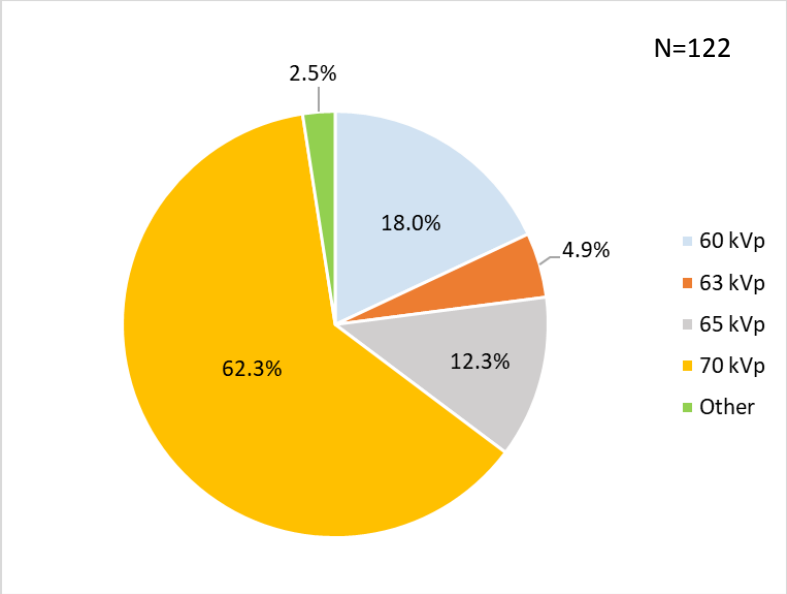


Figure B-15. Stationary intraoral clinical x-ray technique data for the surveyed x-ray unit (kVp) for children.

Table B-20. Stationary Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit (kVp) for Adolescents/Adults.

Stationary I/O Clinical X-ray Technique kVp for Adolescents/Adults	Number	Cumulative Number	Percent	Cumulative Percent
60 kVp	23	23	15.5	15.5
63 kVp	8	31	5.4	20.9
65 kVp	17	48	11.5	32.4
70 kVp	96	144	64.9	97.3
Other	4	148	2.7	100.0

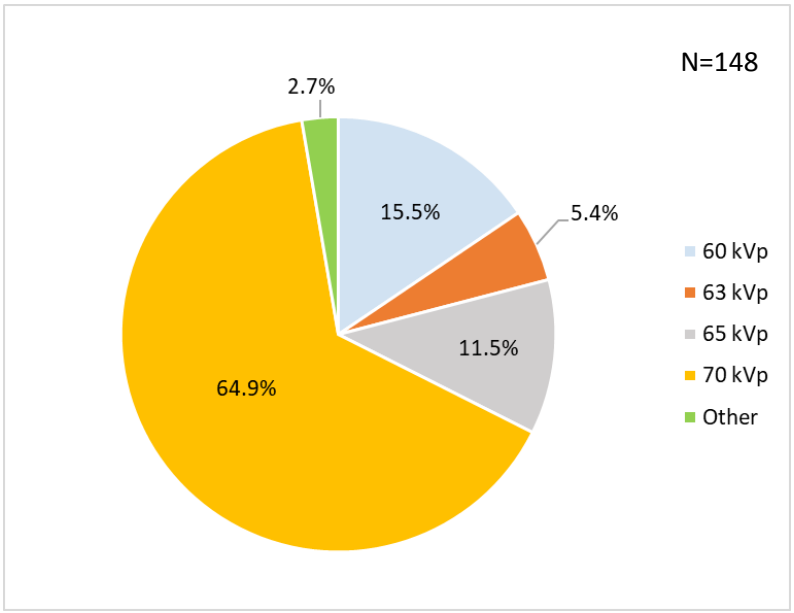


Figure B-16. Stationary intraoral clinical x-ray technique data for the surveyed x-ray unit (kVp) for adolescents/adults.

Table B-21. Handheld Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit (kVp) for Children.

Handheld I/O Clinical X-ray Technique kVp for Children	Number	Cumulative Number	Percent	Cumulative Percent
60 kVp	28	28	93.3	93.3
70 kVp	2	30	6.7	100.0

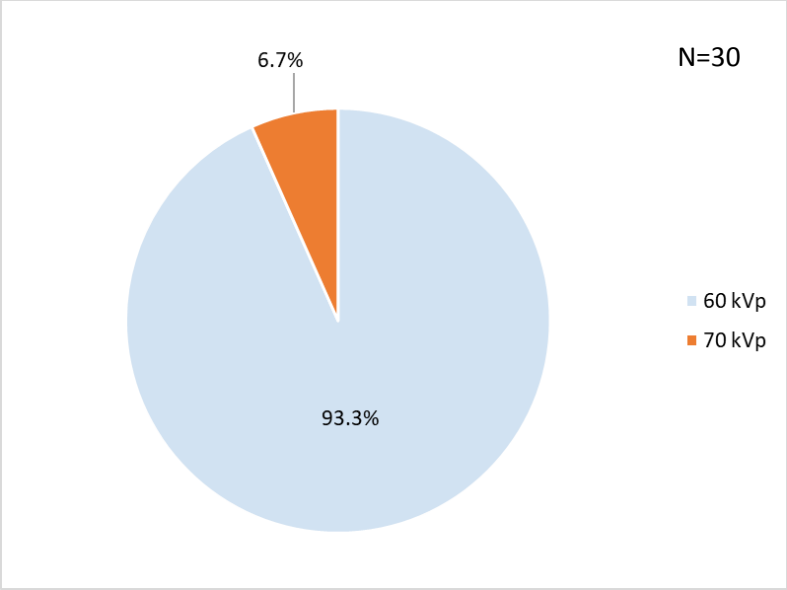


Figure B-17. Handheld intraoral clinical x-ray technique data for the surveyed x-ray unit (kVp) for children.

Table B-22. Handheld Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit (kVp) for Adolescents/Adults.

Handheld I/O Clinical X-ray Technique kVp for Adolescents/Adults	Number	Cumulative Number	Percent	Cumulative Percent
60 kVp	25	25	92.6	92.6
70 kVp	2	27	7.4	100.0

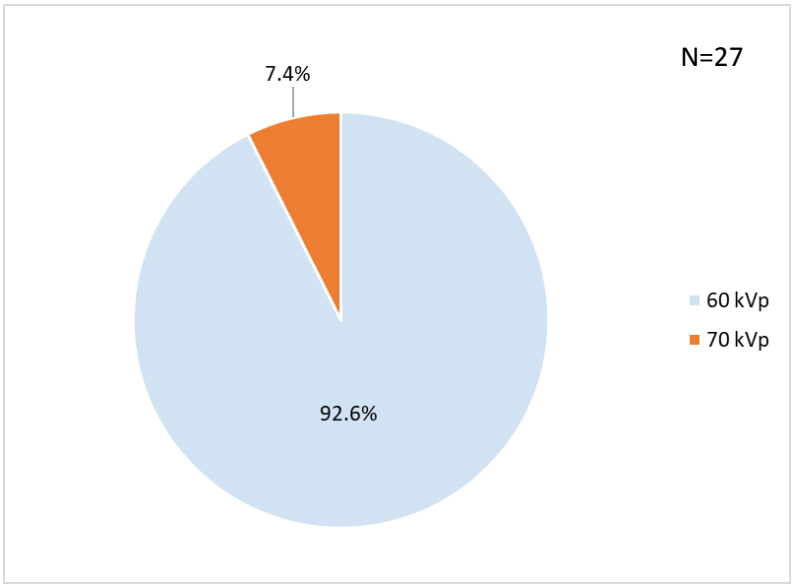


Figure B-18. Handheld intraoral clinical x-ray technique data for the surveyed x-ray unit (kVp) for adolescents/adults.

Table B-23. Stationary Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit (Exposure Time in msec) for Children.

Stationary I/O Clinical X-ray Technique Exposure Time in msec Children	Number	Cumulative Number	Percent	Cumulative Percent
100 or less	56	56	52.8	52.8
101-200	38	94	35.8	88.7
201-300	6	100	5.7	94.3
301-400	3	103	2.8	97.2
401-500	0	103	0.0	97.2
501+	3	106	2.8	100.0

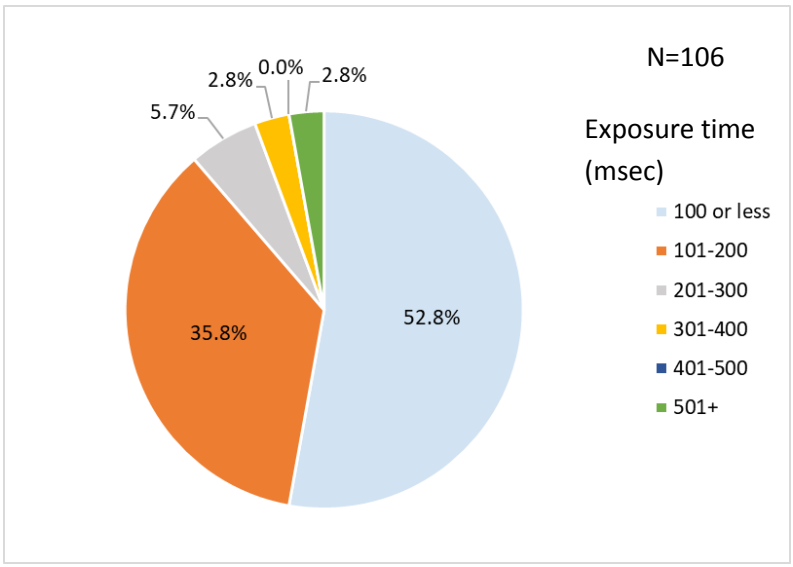


Figure B-19. Stationary intraoral clinical x-ray technique data for the surveyed x-ray unit (exposure time in msec) for children.

No instances of 401-500 exposure times in msec were reported as shown as 0.0% on the chart.

Table B-24. Stationary Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit (Exposure Time in msec) for Adolescents/Adults.

Stationary I/O Clinical X-ray Technique Exposure Time in msec Adolescents/Adults	Number	Cumulative Number	Percent	Cumulative Percent
100 or less	33	33	25.8	25.8
101-200	56	89	43.8	69.5
201-300	17	106	13.3	82.8
301-400	14	120	10.9	93.8
401-500	4	124	3.1	96.9
501+	4	128	3.1	100.0

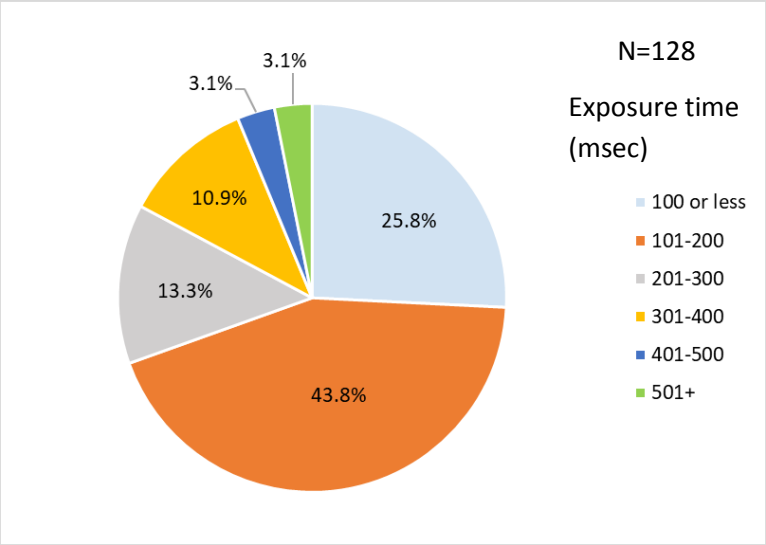


Figure B-20. Stationary intraoral clinical x-ray technique data for the surveyed x-ray unit (exposure time in msec) for adolescents/adults.

Table B-25. Handheld Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit (Exposure Time in msec) for Children.

Handheld I/O Clinical X-ray Technique Exposure Time in msec Children	Number	Cumulative Number	Percent	Cumulative Percent
100 or less	9	9	30.0	30.0
101-200	16	25	53.3	83.3
201-300	3	28	10.0	93.3
301-400	1	29	3.3	96.7
401+	1	30	3.3	100.0

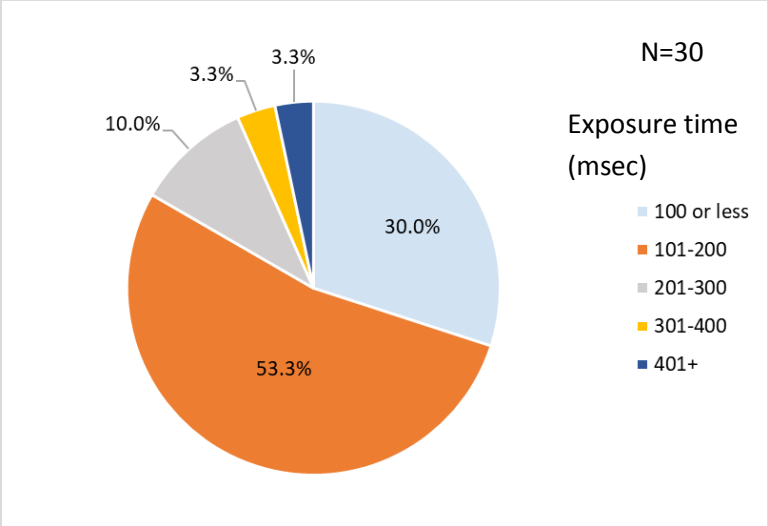


Figure B-21. Handheld intraoral clinical x-ray technique data for the surveyed x-ray unit (exposure time in msec) for children.

Table B-26. Handheld Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit (Exposure Time in msec) for Adolescents/Adults.

Handheld I/O Clinical X-ray Technique Exposure Time in msec Adolescents/Adults	Number	Cumulative Number	Percent	Cumulative Percent
100 or less	2	2	7.4	7.4
101-200	18	20	66.7	74.1
201-300	4	24	14.8	88.9
301-400	2	26	7.4	96.3
401+	1	27	3.7	100.0

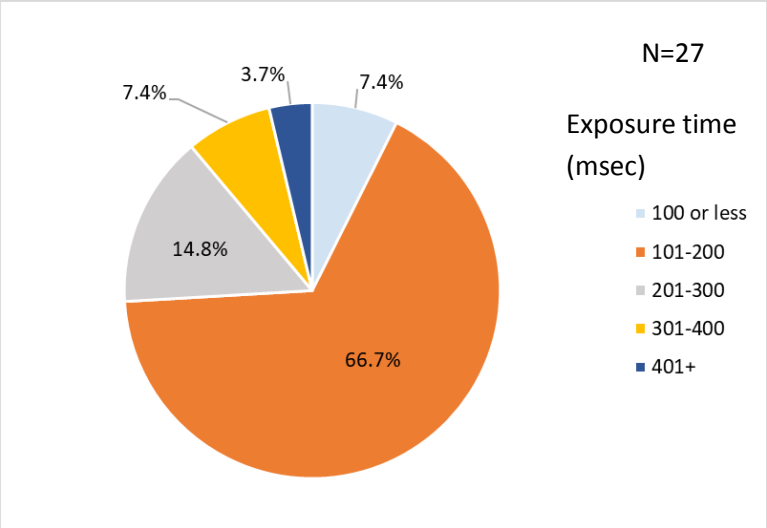


Figure B-22. Handheld intraoral clinical x-ray technique data for the surveyed x-ray unit (exposure time in msec) for adolescents/adults.

Table B-27. Stationary Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit (mA) for Children.

Stationary I/O Clinical X-ray Technique mA Children	Number	Cumulative Number	Percent	Cumulative Percent
7	76	76	62.3	62.3
8	19	95	15.6	77.9
10	17	112	13.9	91.8
Other	10	122	8.2	100.0

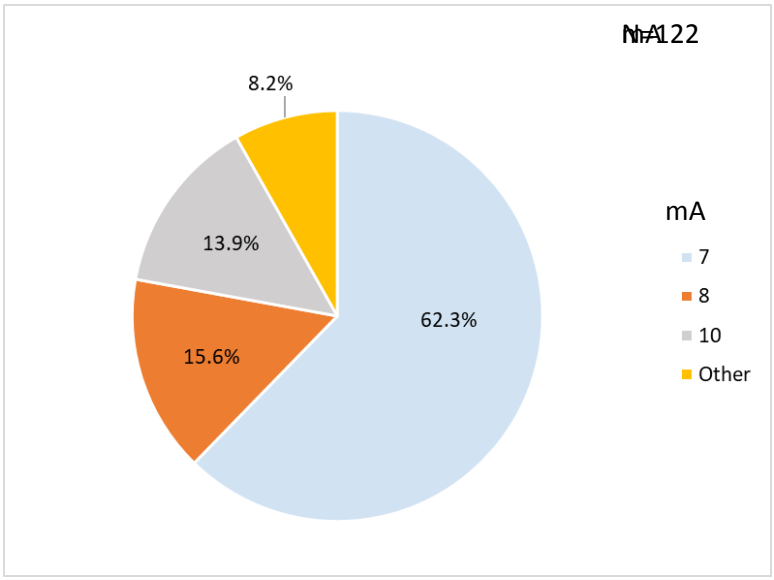


Figure B-23. Stationary Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit (mA) for Children.

Table B-28. Stationary Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit (mA) for Adolescents/Adults.

Stationary I/O Clinical X-ray Technique, mA (Adolescents/Adults)	Number	Cumulative Number	Percent	Cumulative Percent
7	94	94	63.9	63.9
8	20	114	13.6	77.6
10	22	136	15.0	92.5
Other	11	147	7.5	100.0

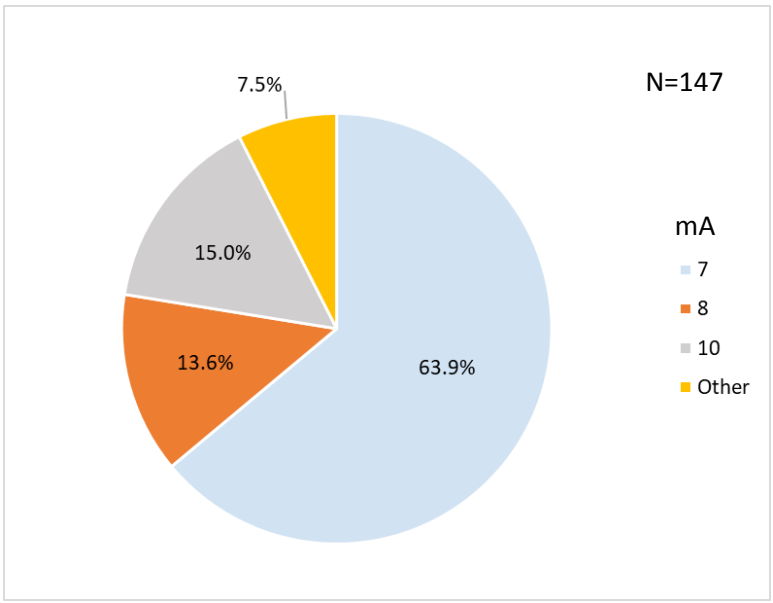


Figure B-24. Stationary intraoral clinical x-ray technique data for the surveyed x-ray unit (mA) for adolescents/adults.

Table B-29. Handheld Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit (mA) for Young Children.

Handheld I/O Clinical X-ray Technique mA Young Children	Number	Cumulative Number	Percent	Cumulative Percent
Less than 2.5	3	3	10.0	10.0
2.5	25	28	83.3	93.3
Greater than 2.5	2	30	6.7	100.0

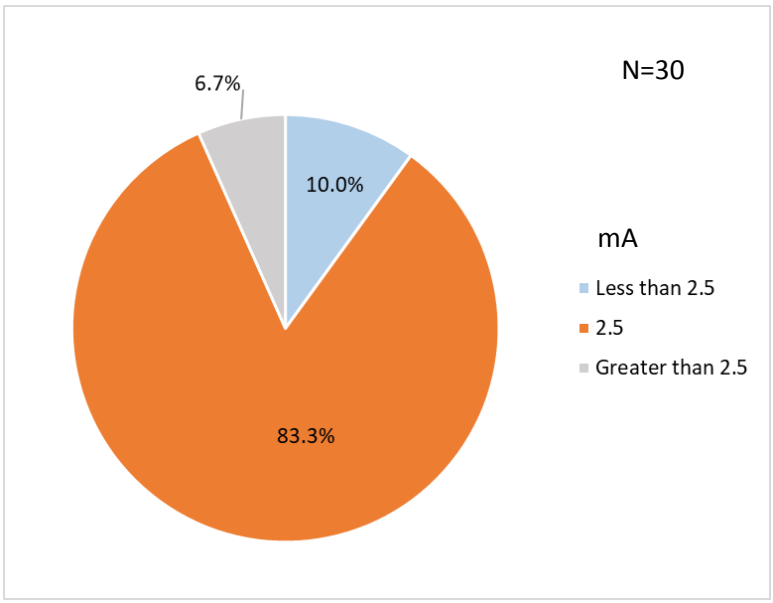


Figure B-25. Handheld intraoral clinical x-ray technique data for the surveyed x-ray unit (mA) for children.

Table B-30. Handheld Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit (mA) for Adolescents/Adults.

Handheld IO Clinical X-ray Technique mA Adolescents/Adults	Number	Cumulative Number	Percent	Cumulative Percent
Less than 2.5	3	3	11.1	11.1
2.5	22	25	81.5	92.6
Greater than 2.5	2	27	7.4	100.0

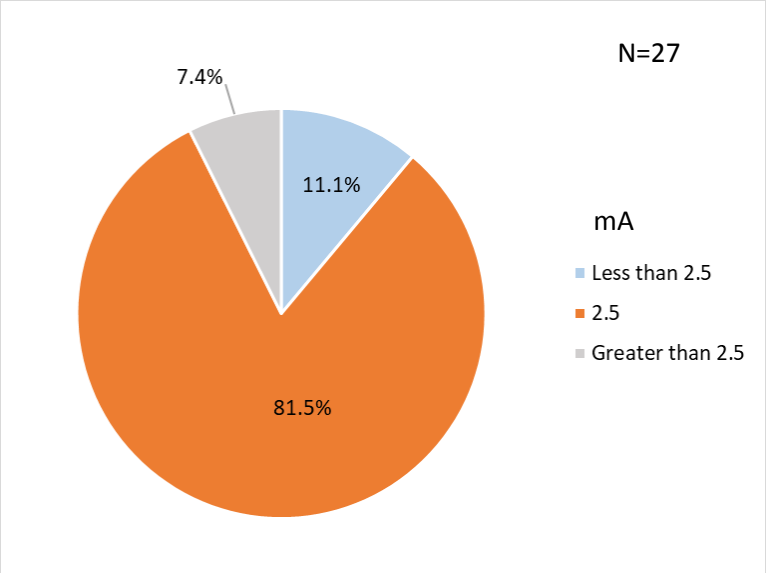


Figure B-26. Handheld intraoral clinical x-ray technique data for the surveyed x-ray unit (mA) for adolescents/adults.

Table B-31. Stationary Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit (mAs) for Children.

Stationary I/O Clinical X-ray Technique mAs Children	Number	Cumulative Number	Percent	Cumulative Percent
1.0 or Less	71	71	67.0	67.0
1.1 - 2.0	23	94	21.7	88.7
2.1 - 3.0	9	103	8.5	97.2
3.1 - 4.0	0	103	0.0	97.2
4.1 +	3	106	2.8	100.0

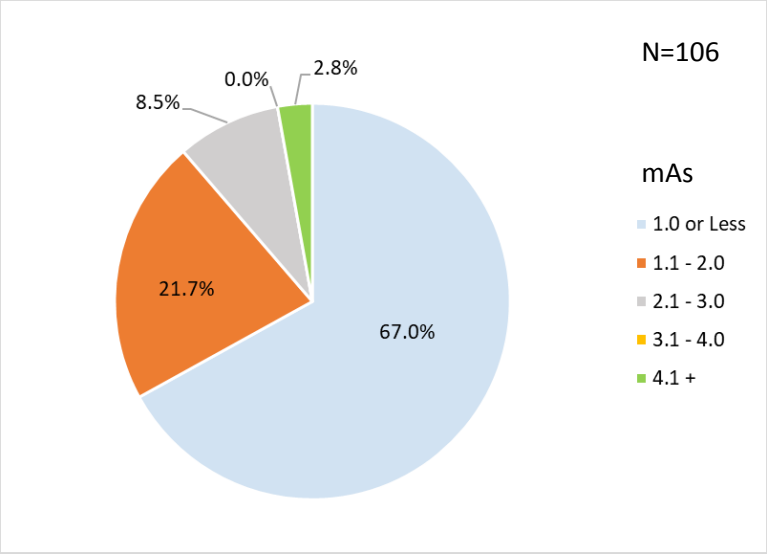


Figure B-27. Stationary intraoral clinical x-ray technique data for the surveyed x-ray unit (mAs) for children.

No instances of 3.1-4.0 mAs were reported, as shown as 0.0% on the chart.

Table B-32. Stationary Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit (mAs) for Adolescents/Adults.

Stationary I/O Clinical X-ray Technique mAs Adolescents/Adults	Number	Cumulative Number	Percent	Cumulative Percent
1.0 or Less	52	52	40.9	40.9
1.1 - 2.0	47	99	37.0	78.0
2.1 - 3.0	16	115	12.6	90.6
3.1 - 4.0	6	121	4.7	95.3
4.1 +	6	127	4.7	100.0

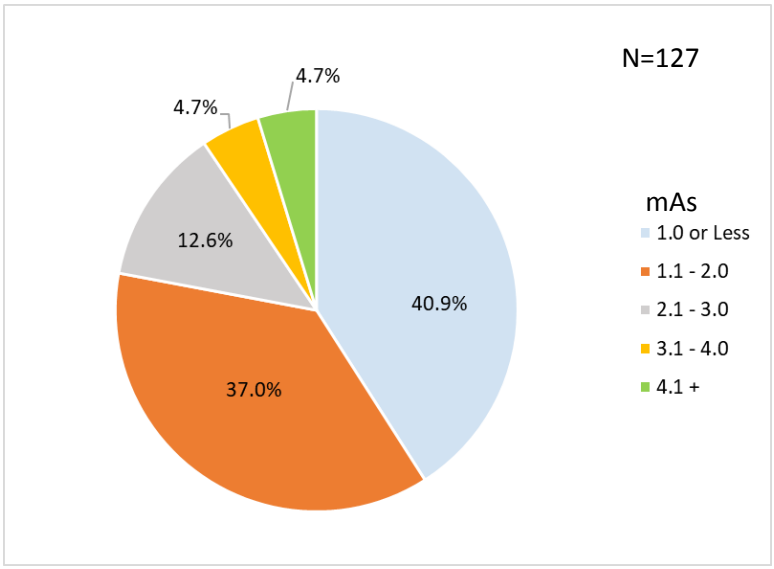


Figure B-28. Stationary intraoral clinical x-ray technique data for the surveyed x-ray unit (mAs) for adolescents/adults.

Table B-33. Handheld Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit (mAs) for Children.

Handheld I/O Clinical X-ray Technique mAs Children	Number	Cumulative Number	Percent	Cumulative Percent
0.5 or Less	23	23	76.7	76.7
0.6 - 1.0	5	28	16.7	93.3
1.1 +	2	30	6.7	100.0

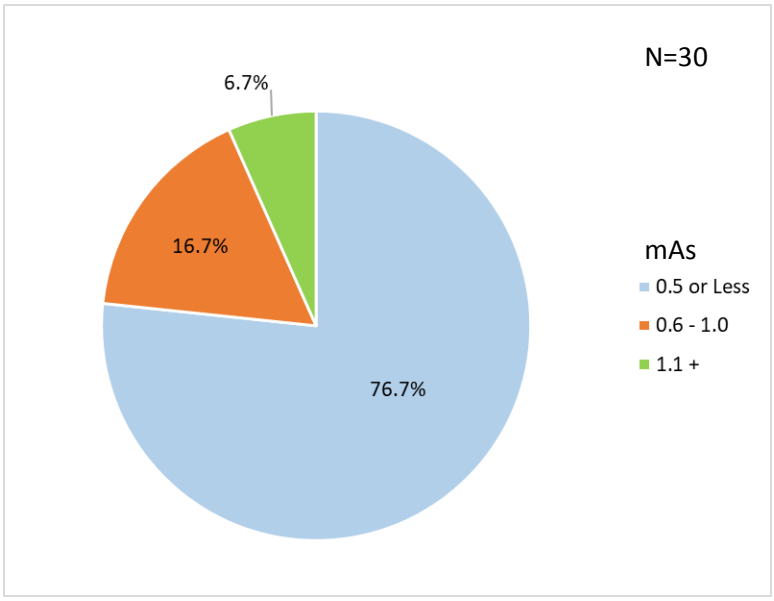


Figure B-29. Handheld intraoral clinical x-ray technique data for the surveyed x-ray unit (mAs) for children.

Table B-34. Handheld Intraoral Clinical X-ray Technique Data for the Surveyed X-ray Unit (mAs) for Adolescents/Adults.

Handheld I/O Clinical X-ray Technique mAs Adolescents/Adults	Number	Cumulative Number	Percent	Cumulative Percent
0.5 or Less	19	19	70.4	70.4
0.6 - 1.0	6	25	22.2	92.6
1.1 +	2	27	7.4	100.0

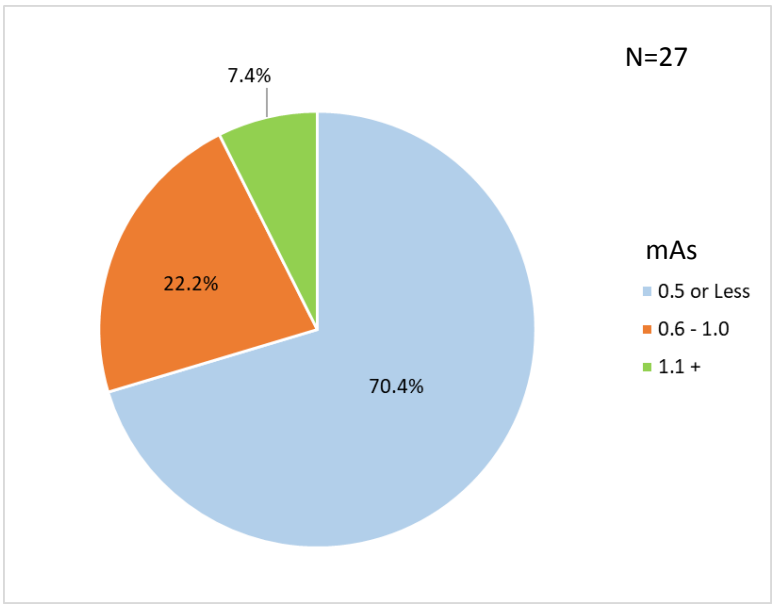


Figure B-30. Handheld intraoral clinical x-ray technique data for the surveyed x-ray unit (mAs) for adolescents/adults.

Table B-35. Stationary and Handheld Intraoral Source-to-Skin Distance for the Surveyed X-ray Unit in cm – Statistical Distribution.

	N	Mean	Std. Dev.	Min	25%	Median	75%	Max
Source-to-Skin Distance (cm)	94	22.1	3.9	10.3	20	20	24	45

Table B-36. Stationary and Handheld Intraoral Source-to-Skin Distance for the Surveyed X-ray Unit in cm.

Source-to-Skin Distance (cm)	Number	Cumulative Number	Percent	Cumulative Percent
18- 20	6	6	6.4	6.4
20-21	53	59	56.4	62.8
22-23	11	70	11.7	74.5
24-25	12	82	12.8	87.2
26+	12	94	12.8	100.0

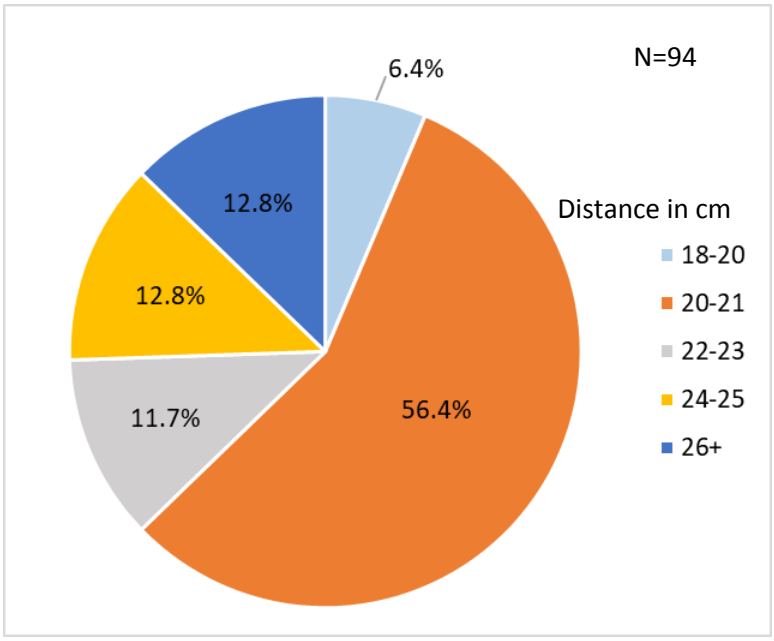


Figure B-31. Stationary and handheld intraoral source-to-skin distance for the surveyed x-ray unit in cm.

Table B-37. Stationary and Handheld Intraoral Collimator Type for the Surveyed X-ray Unit.

Collimator Type	Round	Rectangular
Number	180	1

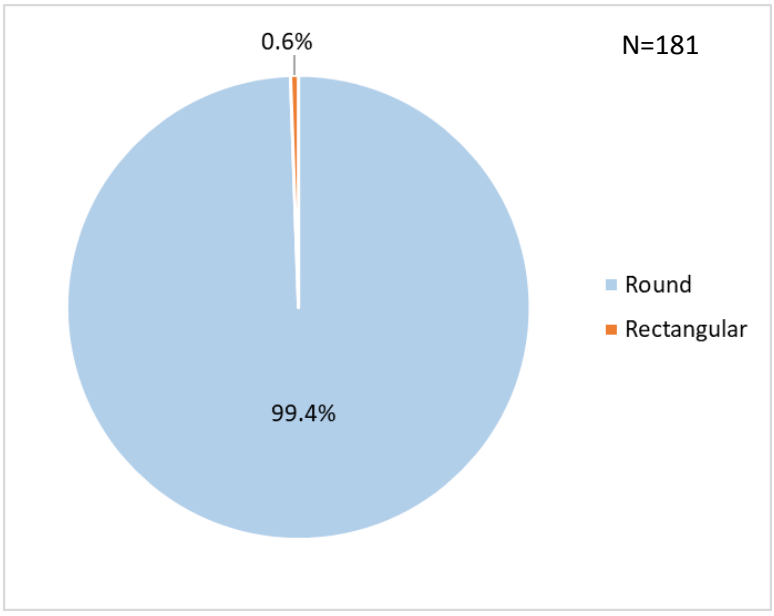


Figure B-32. Percent of stationary and handheld intraoral collimator types for the surveyed x-ray unit.

Table B-38. Stationary and Handheld Intraoral Image Detector/Film Holder (Detector/Film Holder, Patient, or Staff) for the Surveyed X-ray Unit.

Detector/ Film Holder	Number of Units	Detector/Film Holder Number (Percent)	Patient Number (Percent)	Staff Number (Percent)
Stationary	150	112 (74.7)	38 (25.3)	0 (0.0)
Handheld	33	22 (66.7)	10 (30.3)	1 (3.0)

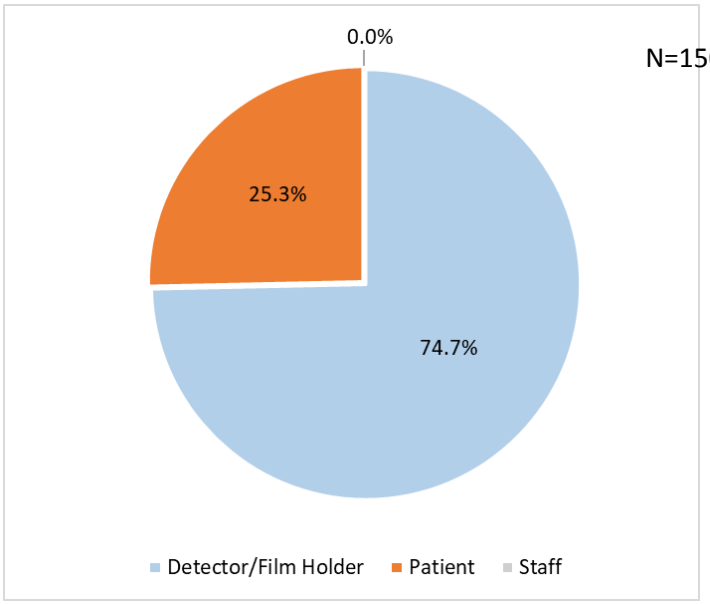


Figure B-33. Stationary intraoral image detector/film holder (detector/film holder, patient, or staff) for the surveyed x-ray unit.

No instances of staff under stationary detector/film holder were reported, as shown as 0.0% on the chart.

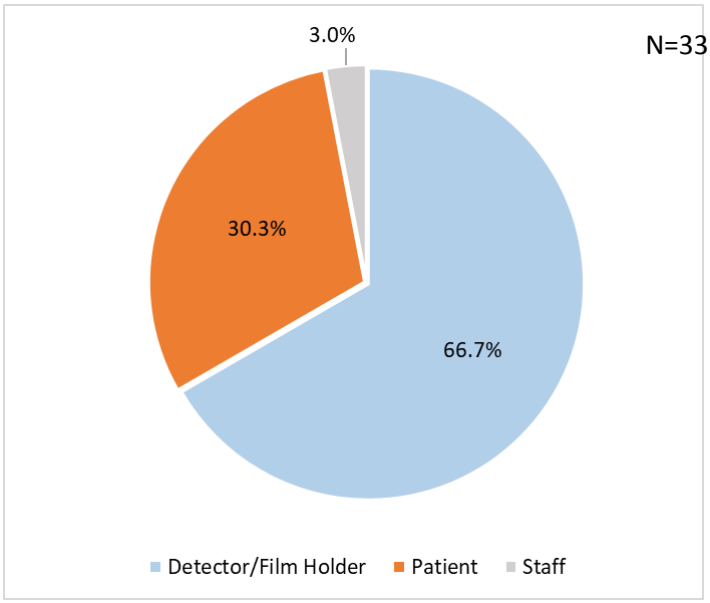


Figure B-34. Handheld intraoral image detector/film holder (detector/film holder, patient, or staff) for the surveyed x-ray unit.

Table B-39. Stationary and Handheld Intraoral Indicated vs. Measured kVp for the Surveyed X-ray Unit – Statistical Distribution.

	N	Mean	Std. Dev.	Min	25%	Median	75%	Max
Indicated kVp - Handheld	32	60.6	2.5	60	60	60	60	70
Measured kVp - Handheld	30	60.4	3.8	50	59	60	61	71
Indicated kVp - Stationary	149	67.3	4	60	65	70	70	70
Measured kVp - Stationary	122	67.1	5.7	55	63	67	71	80

Table B-40. Stationary Intraoral Indicated vs. Measured kVp for the Surveyed X-ray Unit – Percent Difference.

Indicated vs. Measured kVp Percent Difference[a] Stationary	Number	Cumulative Number	Percent	Cumulative Percent
0 - 2	38	38	31.1	31.1
2.01 - 4	28	66	23.0	54.1
4.01 - 6	23	89	18.9	73.0
6.01 - 8	18	107	14.8	87.7
8.01 - 10	5	112	4.1	91.8
10.01+	10	122	8.2	100.0

[a] Percent difference equals the absolute value of the change in value, divided by the average of the 2 numbers, multiplied by 100.

Table B-41. Table B-40. Handheld Intraoral Indicated vs. Measured kVp for the Surveyed X-ray Unit – Percent Difference.

Indicated vs. Measured kVp Percent Difference [a] Handheld	Number	Cumulative Number	Percent	Cumulative Percent
0 - 2	20	20	66.7	66.7
2.01 - 4	3	23	10.0	76.7
4.01 - 6	4	27	13.3	90.0
6.01 - 8	2	29	6.7	96.7
8.01 - 10	0	29	0.0	96.7
10.01+	1	30	3.3	100.0

[a] Percent difference equals the absolute value of the change in value, divided by the average of the 2 numbers, multiplied by 100.

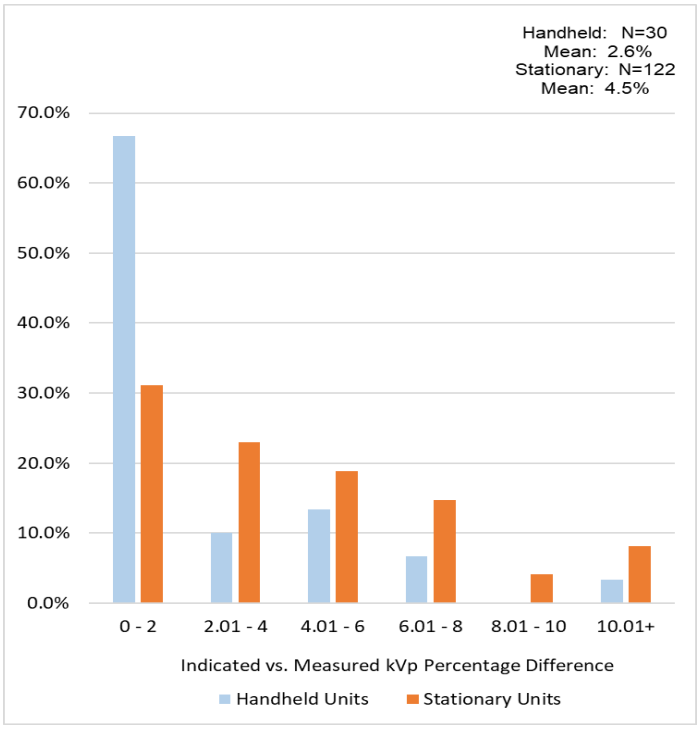


Figure B-35. Stationary and handheld intraoral indicated vs. measured kVp for the surveyed x-ray unit - percent difference.

Percent difference equals the absolute value of the change in value, divided by the average of the 2 numbers, multiplied by 100.

Table B-42. Stationary and Handheld Intraoral Half-Value Layer Measurements for the Surveyed X-ray Unit in mm Al – Statistical Distribution.

	N	Mean	Std. Dev.	Min	25%	Median	75%	Max
HVL (mm) - Handheld units	30	1.8	0.3	1.3	1.6	1.7	2	2.4
HVL (mm) - Stationary units	143	2.1	0.3	1.5	1.9	2.1	2.2	3.4

Table B-43. Stationary Intraoral Half-Value Layer (HVL) Measurements for the Surveyed X-ray Unit in mm Al.

HVL (mm) - Stationary Units	Number	Cumulative Number	Percent	Cumulative Percent
Less than 1.5	0	6	0.0	4.0
1.51-2.00	58	64	38.9	43.0
2.01-2.50	74	138	49.7	92.6
2.51+	11	149	7.4	100.0

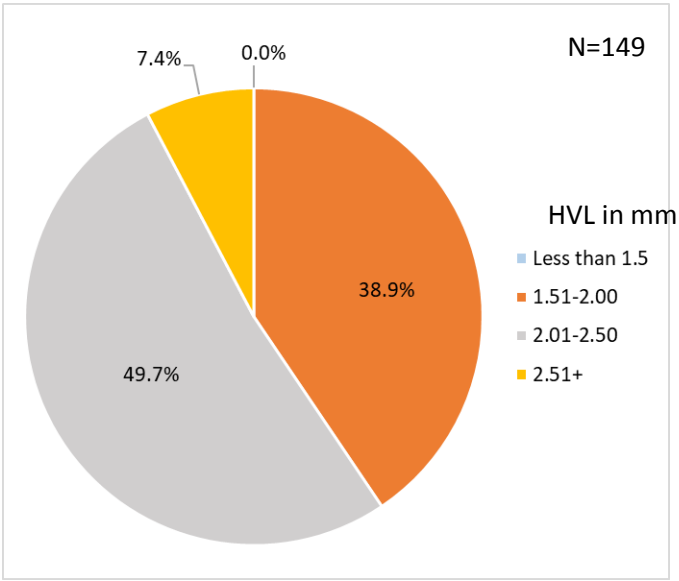


Figure B-36. Stationary intraoral half-value layer (HVL) measurements for the surveyed x-ray unit in mm Al.

No instances of less than 1.5 HVL in mm were reported, as shown by 0.0% in the chart.

Table B-44. Handheld Intraoral Half-Value Layer Measurements for the Surveyed X-ray Unit in mm Al.

HVL (mm) - Handheld Units	Number	Cumulative Number	Percent	Cumulative Percent
Less than 1.5	6	6	7.3	7.3
1.51-2.00	53	59	64.6	72.0
2.01-2.50	11	70	13.4	85.4
2.51+	12	82	14.6	100.0

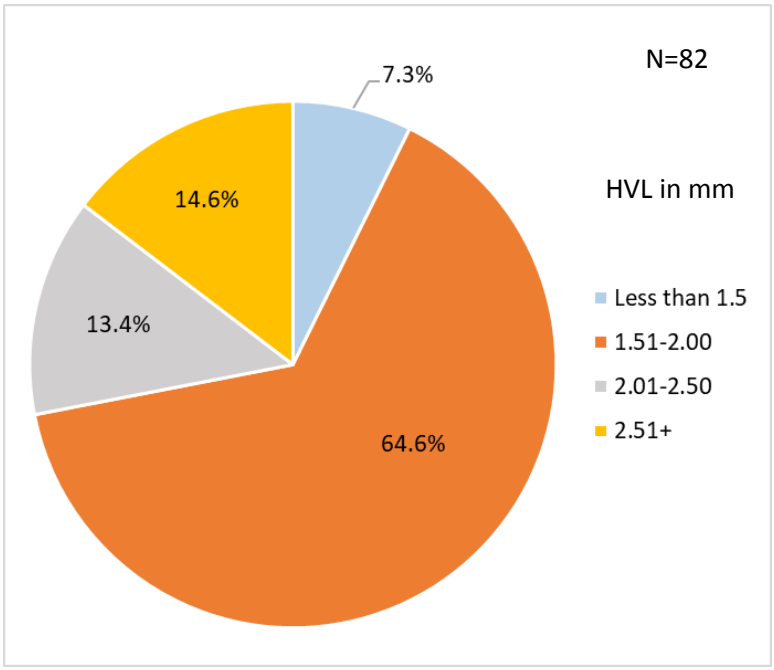


Figure B-37. Handheld intraoral half-value layer measurements for the surveyed x-ray unit in mm Al.

Table B-45. Stationary and Handheld Intraoral Entrance Air Kerma (mGy) and Entrance Skin Exposure (mR) Values for the Surveyed X-ray Unit for Adults and Children per Exposure – Statistical Distribution.

	N	Mean	Std. Dev.	Min	25%	Median	75%	Max
Air Kerma Adults (mGy)	177	1.07	0.70	0.05	0.58	0.86	1.48	3.95
Air Kerma Children (mGy)	144	0.73	0.49	0.05	0.39	0.60	0.95	3.15
Exposure Adults (mR)	177	122	80	5.9	66	98	169	451
Exposure Children (mR)	144	83	55.5	5.9	44	68	109	360

Conversion factor: 1.0 mGy = 1.0 mR x 0.00876

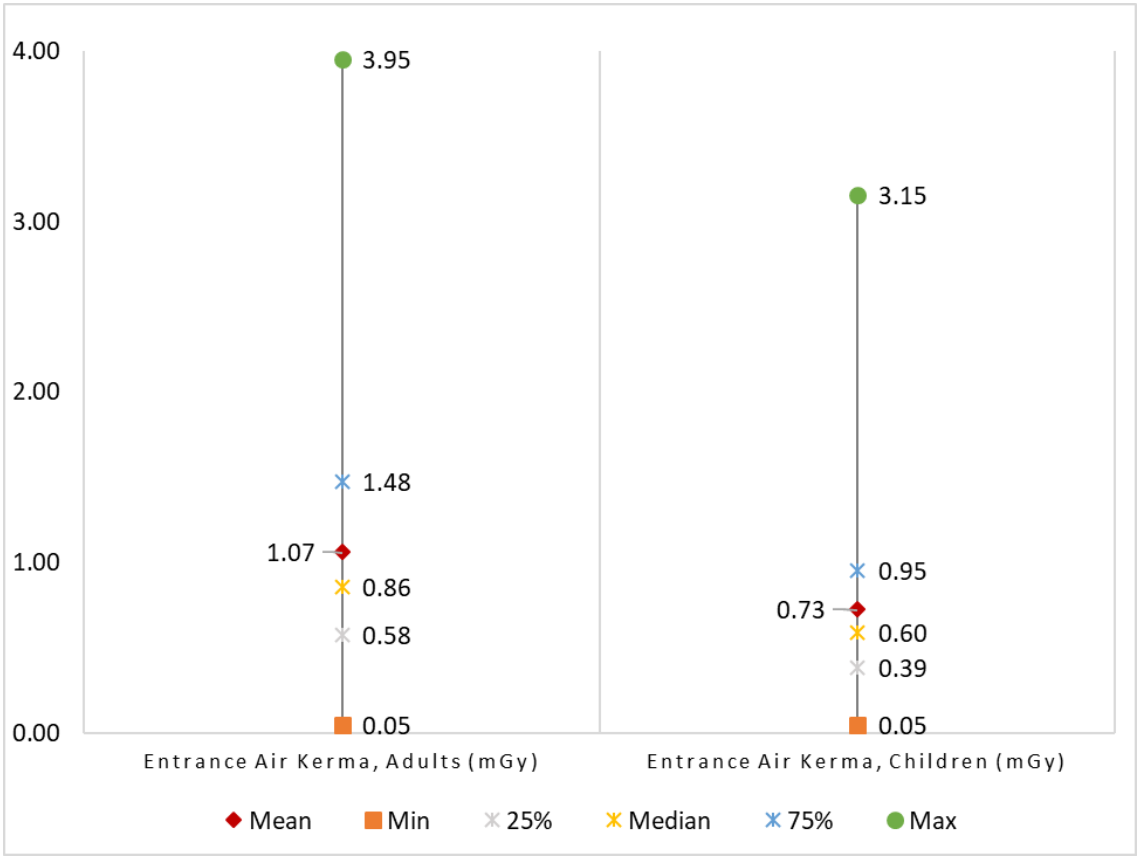


Figure B-38. Stationary and handheld intraoral entrance air kerma (mGy) values for the surveyed x-ray unit for adults and children per exposure.

Table B-46. Stationary Intraoral Entrance Air Kerma (mGy) and Entrance Skin Exposure (mR) Values for the Surveyed X-ray Unit for Adults and Children per Exposure – Statistical Distribution.

	N	Mean	Std. Dev.	Min	25%	Median	75%	Max
Air Kerma Adults (mGy)	147	1.15	0.68	0.05	0.65	0.95	1.56	3.95
Air Kerma Children (mGy)	116	0.77	0.50	0.05	0.41	0.67	1.02	3.15
Exposure Adults (mR)	147	131.3	77.8	5.9	74	109	178	451
Exposure Children (mR)	116	87.8	57	6	47	77	116	360

Conversion factor: 1.0 mGy = 1.0 mR x 0.00876

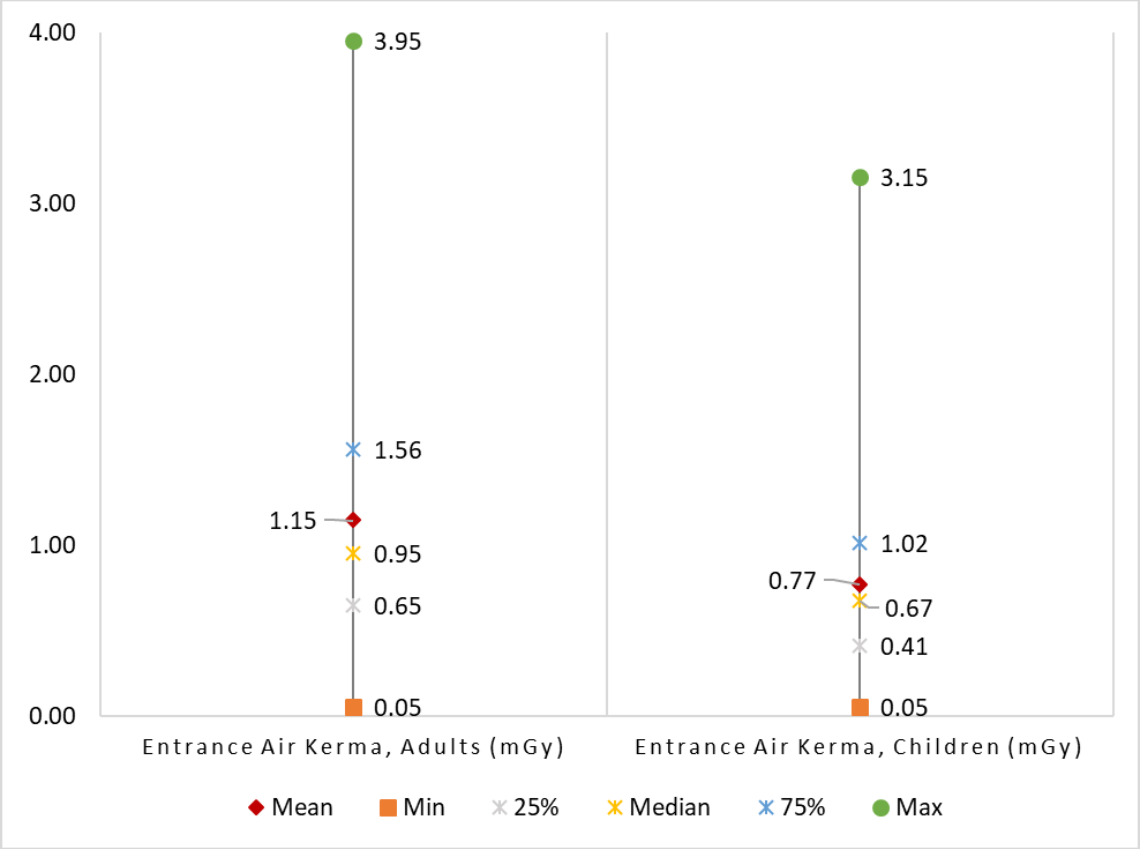


Figure B-39. Stationary intraoral entrance air kerma (mGy) values for the surveyed x-ray unit for adults and children per exposure.

Table B-47. Handheld Intraoral Entrance Air Kerma (mGy) and Entrance Skin Exposure (mR) Values for the Surveyed X-ray Unit for Adults and Children per Exposure – Statistical Distribution.

	N	Mean	Std. Dev.	Min	25%	Median	75%	Max
Air Kerma Adults (mGy)	29	0.66	0.46	0.14	0.41	0.50	0.69	2.14
Air Kerma Children (mGy)	28	0.55	0.39	0.11	0.33	0.42	0.58	1.75
Exposure Adults (mR)	29	75.1	52.2	16.2	46.8	57	79	244
Exposure Children (mR)	28	62.6	44.6	13	38	48	66	200

Conversion factor: 1.0 mGy = 1.0 mR x 0.00876

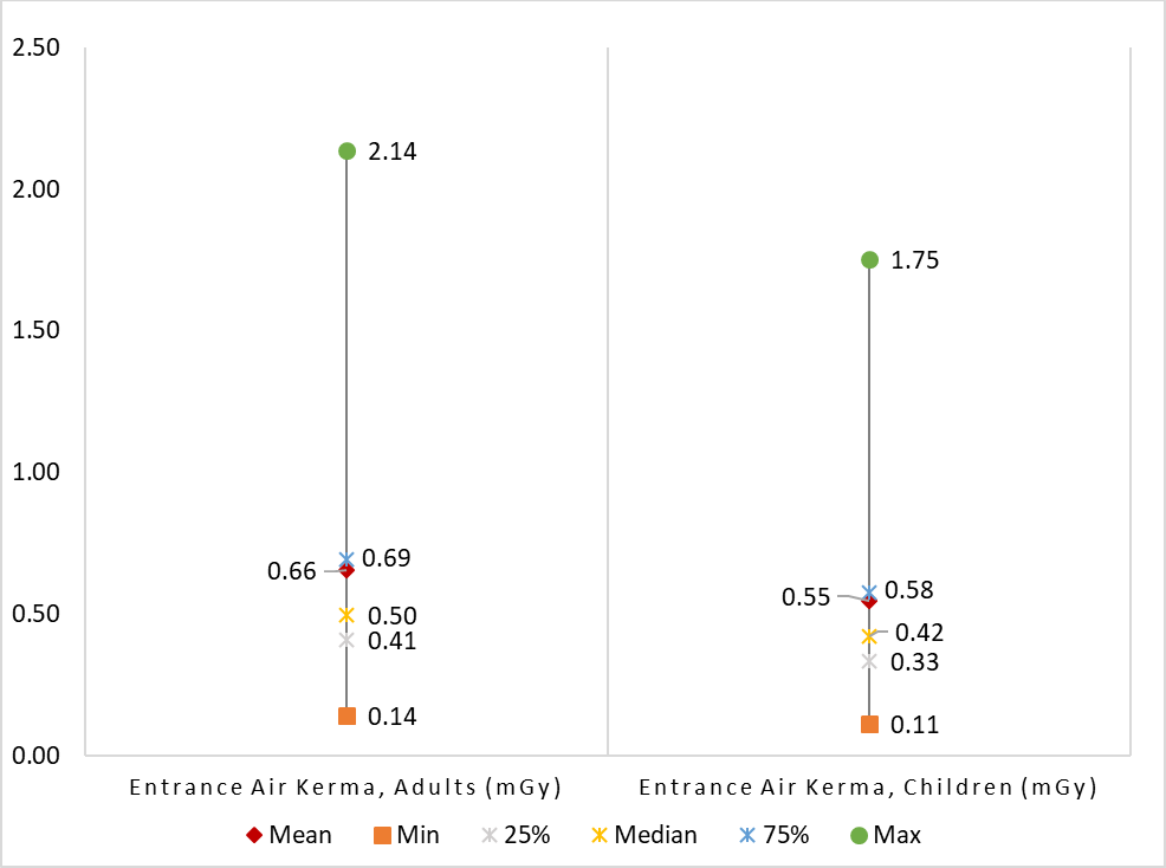


Figure B-40. Handheld intraoral entrance air kerma (mGy) values for the surveyed x-ray unit for adults and children per exposure.

Table B-48. Stationary and Handheld Intraoral Entrance Air Kerma (mGy) Values for the Surveyed X-ray Unit for Adults per Exposure.

Entrance Air Kerma Adults (mGy)	Number	Cumulative Number	Percent	Cumulative Percent
< 0.5	35	35	19.8	19.8
0.5 - 1.0	66	101	37.3	57.1
1.01 - 1.50	34	135	19.2	76.3
1.51 - 2.0	24	159	13.6	89.8
2.01 - 2.50	10	169	5.6	95.5
2.51 - 3.0	5	174	2.8	98.3
> 3.0	3	177	1.7	100.0

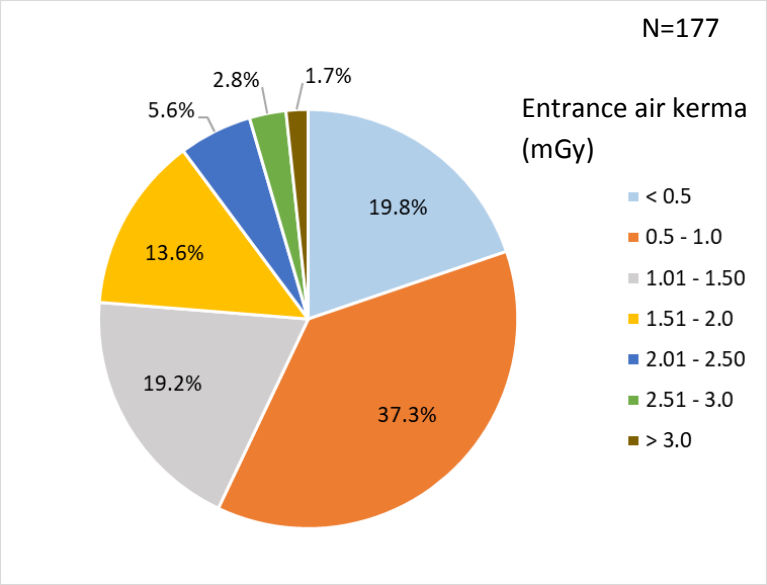


Figure B-41. Stationary and handheld intraoral entrance air kerma (mGy) values for the surveyed x-ray unit for adults per exposure.

Table B-49. Stationary and Handheld Intraoral Entrance Air Kerma (mGy) Values for the Surveyed X-ray Unit for Children per Exposure.

Entrance Air Kerma Children (mGy)	Number	Cumulative Number	Percent	Cumulative Percent
< 0.5	56	56	38.9	38.9
0.5 - 1.0	54	110	37.5	76.4
1.01 - 1.50	23	133	16.0	92.4
1.51 - 2.0	9	142	6.3	98.6
2.01 - 2.50	0	142	0.0	98.6
2.51 - 3.0	1	143	0.7	99.3
> 3.0	1	144	0.7	100.0

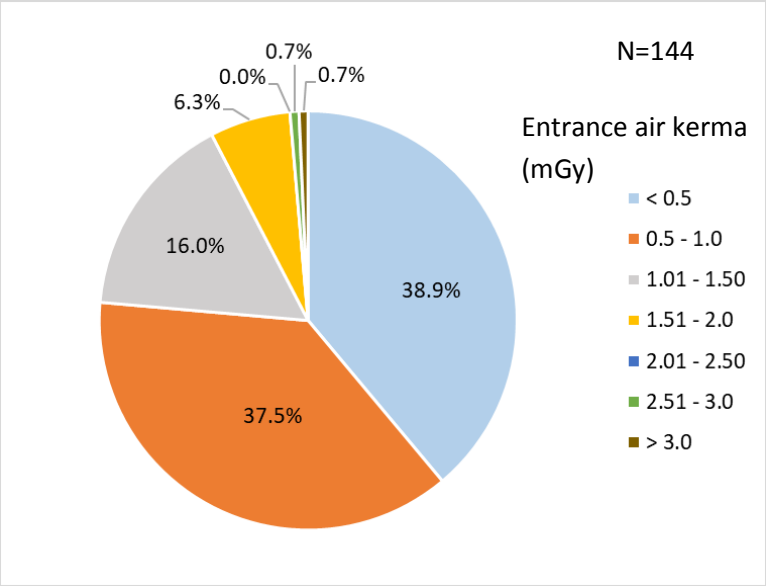


Figure B-42. Stationary and handheld intraoral entrance air kerma (mGy) values for the surveyed x-ray unit for children per exposure.

No instances of 2.01-3.0 entrance air kerma (mGy) were reported, as shown as 0.0% on the chart.

Table B-50. Stationary Intraoral Entrance Air Kerma (mGy) Values for the Surveyed X-ray Unit for Adults per Exposure.

Entrance Air Kerma Adults (mGy)	Number	Cumulative Number	Percent	Cumulative Percent
< 0.5	22	22	15.0	15.0
0.5 - 1.0	54	76	36.7	51.7
1.01 - 1.50	32	108	21.8	73.5
1.51 - 2.0	22	130	15.0	88.4
2.01 - 2.50	9	139	6.1	94.6
2.51 - 3.0	5	144	3.4	98.0
> 3.0	3	147	2.0	100.0

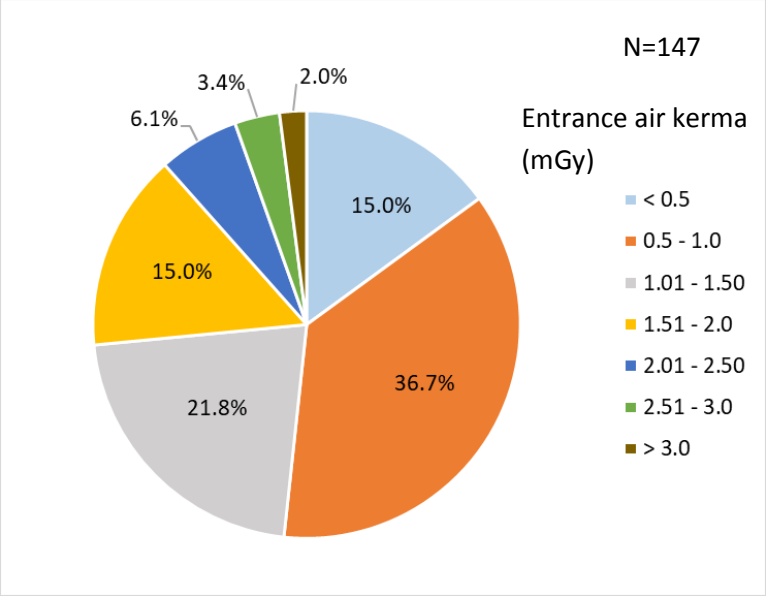


Figure B-43. Stationary intraoral entrance air kerma (mGy) values for the surveyed x-ray unit for adults per exposure.

Table B-51. Stationary Intraoral Entrance Air Kerma (mGy) Values for the Surveyed X-ray Unit for Children per Exposure.

Entrance Air Kerma, Children (mGy)	Number	Cumulative Number	Percent	Cumulative Percent
< 0.5	40	40	34.8	34.8
0.5 - 1.0	44	84	38.3	73.0
1.01 - 1.50	22	106	19.1	92.2
1.51 - 2.0	7	113	6.1	98.3
2.01 - 2.50	0	113	0.0	98.3
2.51 - 3.0	1	114	0.9	99.1
> 3.0	1	115	0.9	100.0

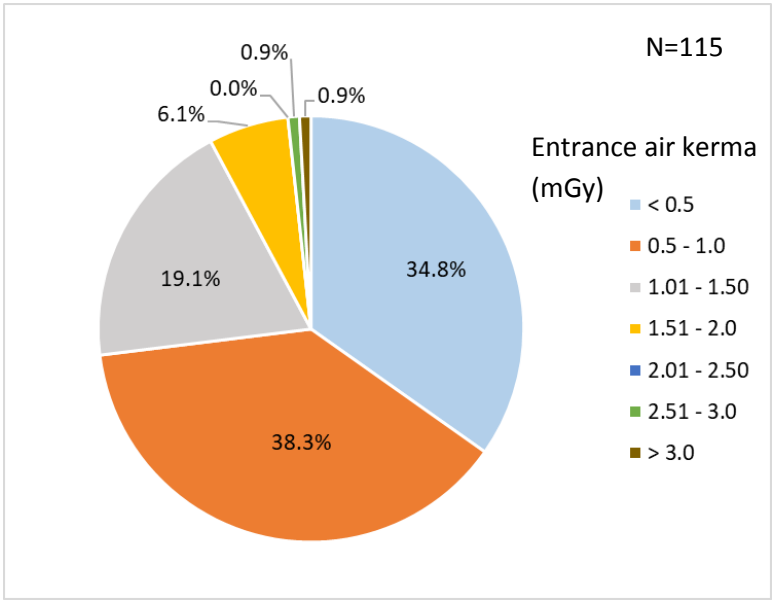


Figure B-44. Stationary intraoral entrance air kerma (mGy) values for the surveyed x-ray unit for children per exposure.

No instances of 2.01-2.50 entrance air kerma (mGy) were reported, as shown as 0.0% on the chart.

Table B-52. Handheld Intraoral Entrance Air Kerma (mGy) Values for the Surveyed X-ray Unit for Adults per Exposure.

Entrance Air Kerma, Adults (mGy)	Number	Cumulative Number	Percent	Cumulative Percent
< 0.5	14	14	48.3	48.3
0.5 - 1.0	11	25	37.9	86.2
1.01 - 1.50	1	26	3.4	89.7
1.51 - 2.0	2	28	6.9	96.6
2.01 - 2.50	1	29	3.4	100.0
2.51 - 3.0	0	29	0.0	100.0
> 3.0	0	29	0.0	100.0

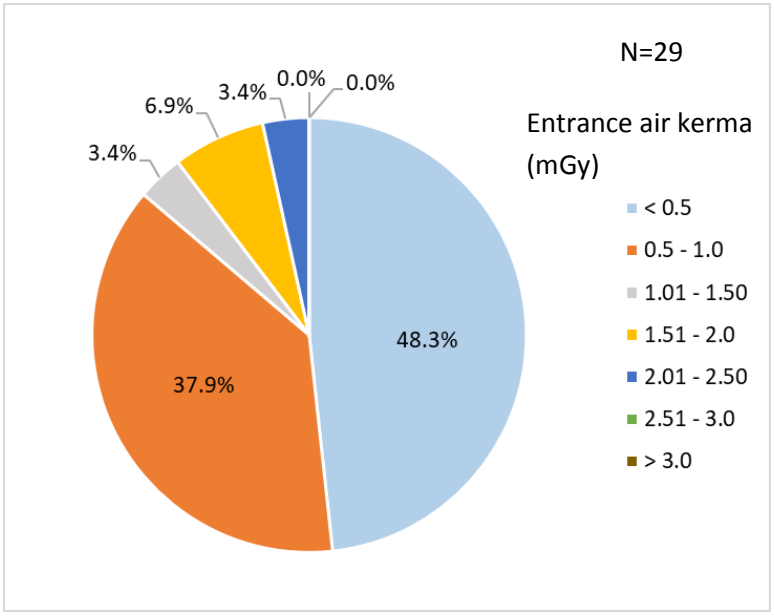


Figure B-45. Handheld intraoral entrance air kerma (mGy) values for the surveyed x-ray unit for adults per exposure.

No instances of 2.51-3.0 and > 3.0 entrance air kerma (mGy) were reported, as shown as 0.0% on the chart.

Table B-53. Handheld Intraoral Entrance Air Kerma (mGy) Values for the Surveyed X-ray Unit for Children per Exposure.

Entrance Air Kerma Children (mGy)	Number	Cumulative Number	Percent	Cumulative Percent
< 0.5	16	16	57.1	57.1
0.5 - 1.0	9	25	32.1	89.3
1.01 - 1.50	1	26	3.6	92.9
1.51 - 2.0	2	28	7.1	100.0
2.01 - 2.50	0	28	0.0	100.0
2.51 - 3.0	0	28	0.0	100.0
> 3.0	0	28	0.0	100.0

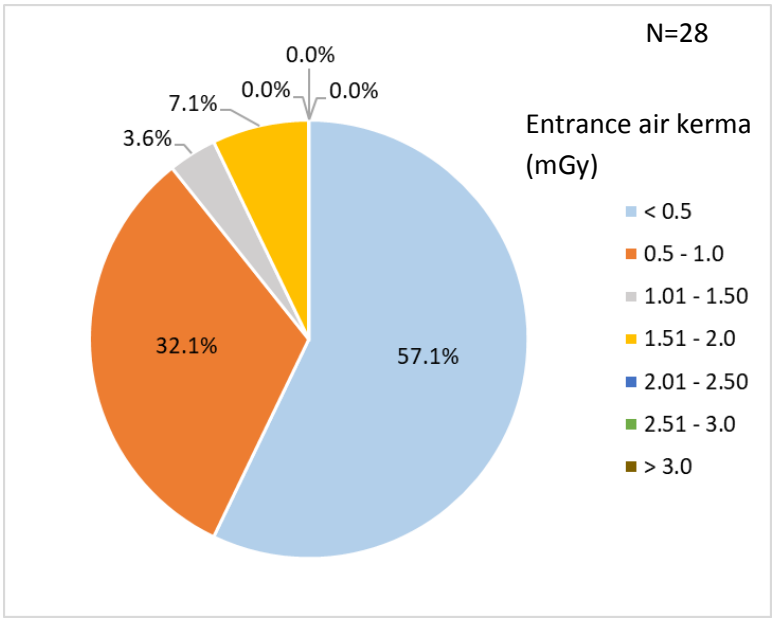


Figure B-46. Handheld intraoral entrance air kerma (mGy) values for the surveyed x-ray unit for children per exposure.

No instances of 2.01-2.50, 2.51-3.0 and > 3.0 mGy were reported, as shown as 0.0% on the chart.

Table B-54. Stationary and Handheld Intraoral Image Quality - Number of Visible Meshes for the Surveyed X-ray Unit

Visible Meshes All Intraoral Units	Number	Cumulative Number	Percent	Cumulative Percent
0	4	4	2.3	2.3
1	6	10	3.5	5.8
2	21	31	12.2	18.0
3	97	128	56.4	74.4
4	44	172	25.6	100.0

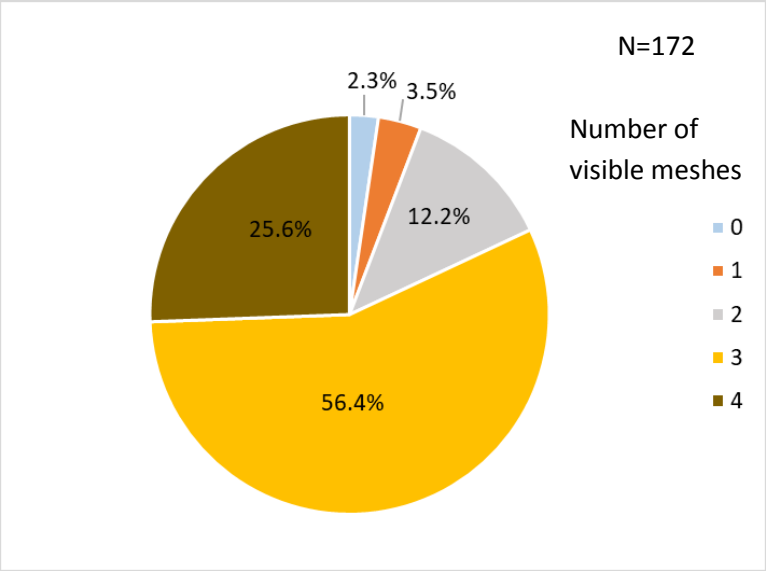


Figure B-47. Stationary and handheld intraoral image quality number of visible meshes for the surveyed x-ray unit.

Table B-55. Stationary Intraoral Image Quality - Number of Visible Meshes for the Surveyed X-ray Unit.

Visible Meshes Stationary Units	Number	Cumulative Number	Percent	Cumulative Percent
0	4	4	2.9	2.9
1	6	10	4.3	7.2
2	20	30	14.4	21.6
3	78	108	56.1	77.7
4	31	139	22.3	100.0

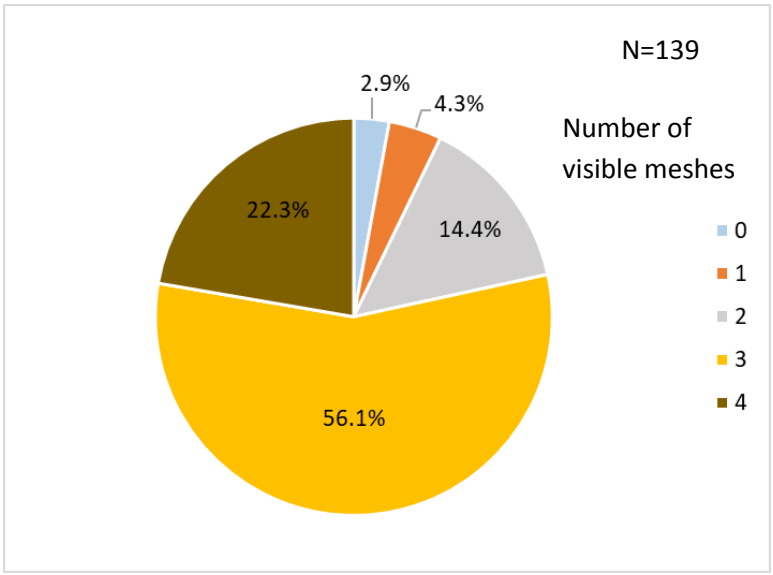


Figure B-48. Stationary intraoral image quality number of visible meshes for the surveyed x-ray unit.

Table B-56. Handheld Intraoral Image Quality - Number of Visible Meshes for the Surveyed X-ray Unit.

Visible Meshes Handheld Units	Number	Cumulative Number	Percent	Cumulative Percent
0	0	0	0.0	0.0
1	0	0	0.0	0.0
2	1	1	3.1	3.1
3	18	19	56.3	59.4
4	13	32	40.6	100.0

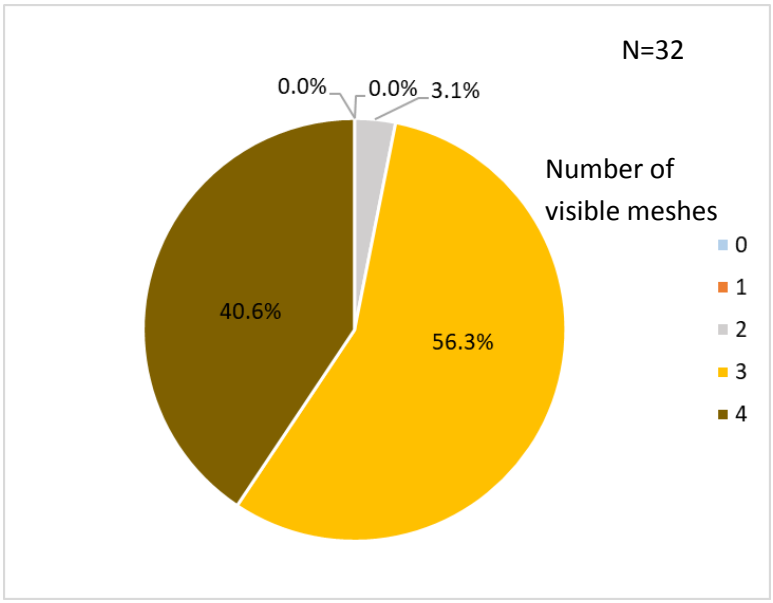


Figure B-49. Handheld intraoral image quality number of visible meshes for the surveyed x-ray unit.

No instances of 0 and 1 visible meshes were reported, as shown as 0.0% on the chart.

Table B-57. Stationary and Handheld Intraoral Image Quality - Number of Visible Meshes for the Surveyed X-ray Unit Utilizing a Digital Image Receptor (CR and DR).

Visible Meshes Digital Units	Number	Cumulative Number	Percent	Cumulative Percent
0	1	1	0.7	0.7
1	3	4	2.1	2.8
2	15	19	10.4	13.2
3	84	103	58.3	71.5
4	41	144	28.5	100.0

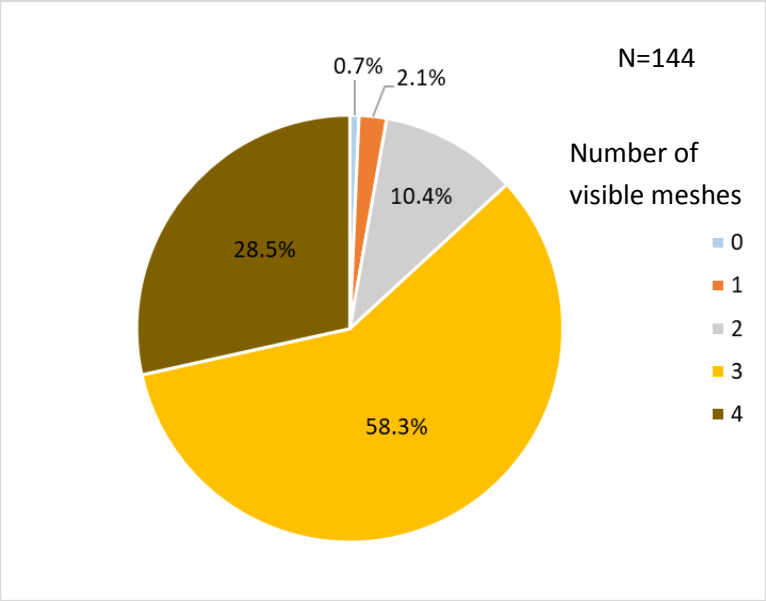


Figure B-50. Stationary and handheld intraoral image quality number of visible meshes for the surveyed x-ray unit utilizing a digital image receptor (CR and DR).

Table B-58. Stationary and Handheld Intraoral Image Quality - Number of Visible Meshes for the Surveyed X-ray Unit Utilizing Film.

Visible Meshes Film Units	Number	Cumulative Number	Percent	Cumulative Percent
0	3	3	12.0	12.0
1	2	5	8.0	20.0
2	6	11	24.0	44.0
3	13	24	52.0	96.0
4	1	25	4.0	100.0

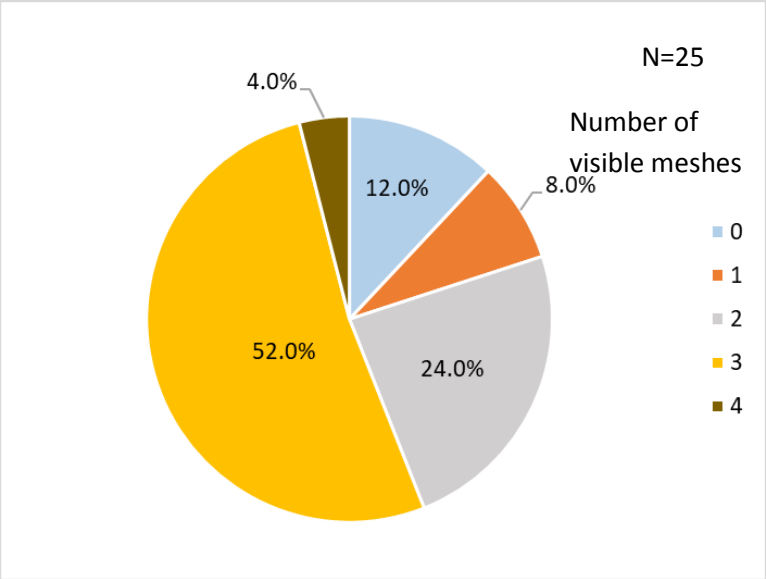


Figure B-51. Stationary and handheld intraoral image quality number of visible meshes for the surveyed x-ray unit utilizing film.

APPENDIX C - PANORAMIC PROCEDURES

Table C-1. Type Panoramic Unit – Digital vs. Film

Type of Panoramic Unit	Frequency	Cumulative Frequency	Percent	Cumulative Percent
Digital	90	90	78.9	78.9
Film	24	114	21.1	100.0

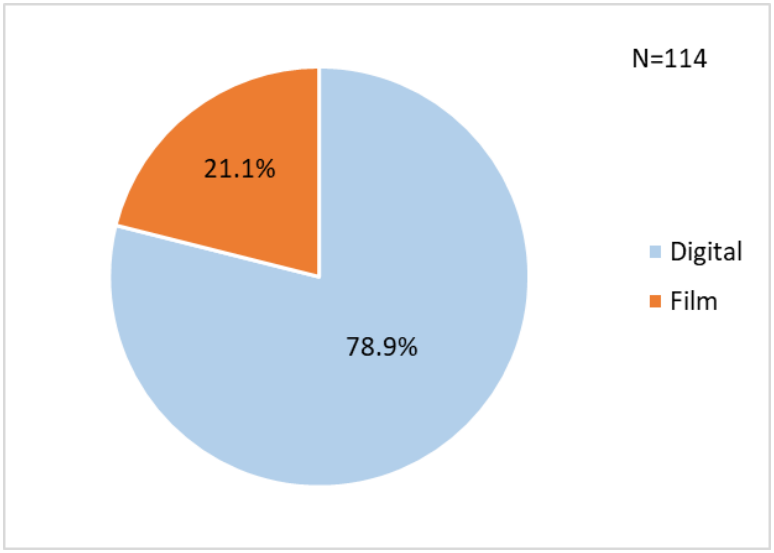


Figure C-1. Percent of panoramic units using digital vs. film.

Table C-2. Panoramic Unit Year of Manufacture

Panoramic Unit Year of Manufacture	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 2000	18	18	17.5	17.5
2000 - 2010	54	72	52.4	69.9
> 2011	31	103	30.1	100.0

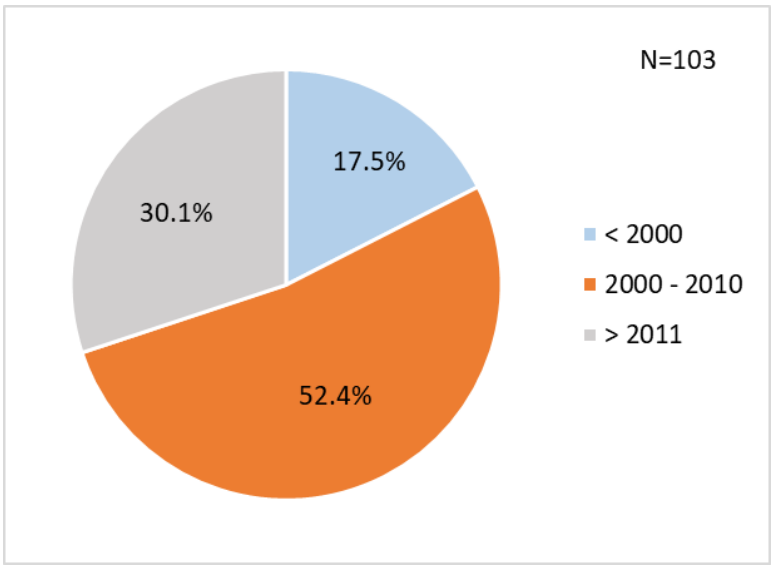


Figure C-2. Percent of panoramic units by year of manufacture.

Table C-3. Panoramic Unit Certification Label

Panoramic Unit Certification Label	Frequency	Cumulative Frequency	Percent	Cumulative Percent
Yes	95	95	91.3	91.3
No	6	101	5.8	97.1
No Answer	3	104	2.9	100.0

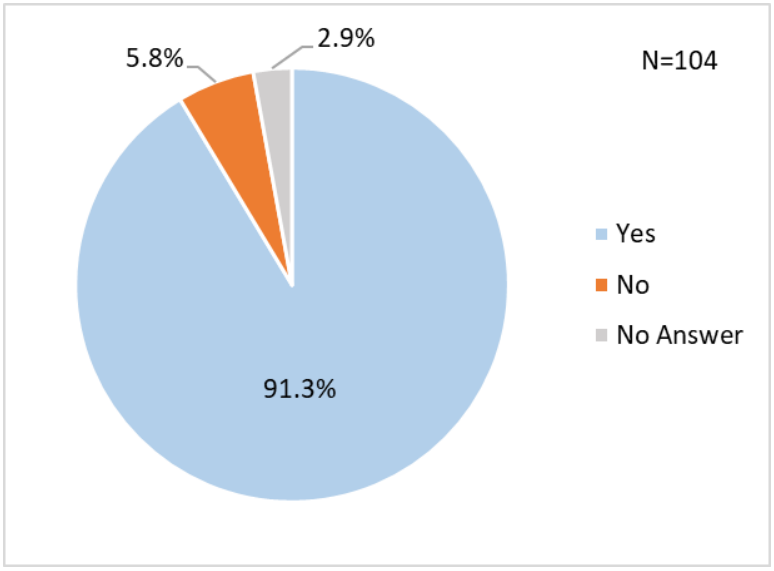


Figure C-3. Percent of panoramic units with certification label.

Table C-4. Panoramic Units Cephalometric Exam Capable

Panoramic Units Cephalometric Exam Capable	Frequency	Cumulative Frequency	Percent	Cumulative Percent
Yes	22	22	19.1%	19.1
No	91	113	79.1%	98.3
No Answer	2	115	1.7%	100.0

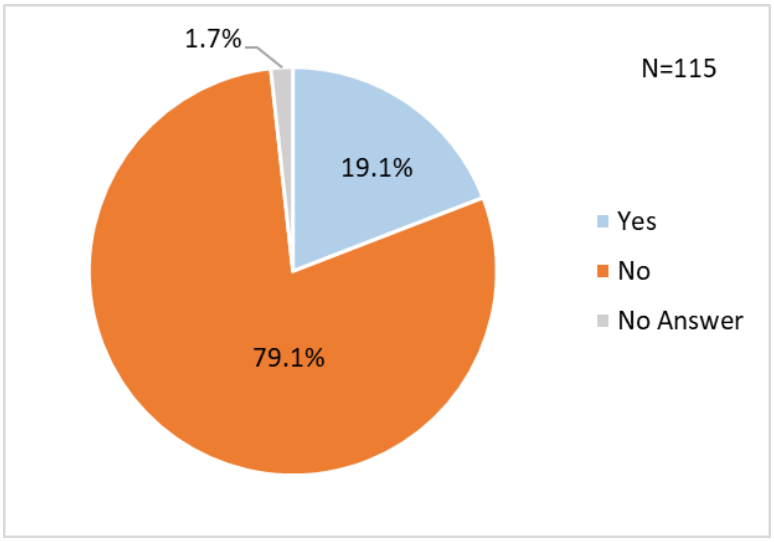


Figure C-4. Percent of panoramic units that are cephalometric exam capable.

Table C-5. Panoramic Unit with Dose Index on Console

Panoramic Unit Dose Display on Console	Frequency	Cumulative Frequency	Percent	Cumulative Percent
Yes	17	17	14.9	14.9
No	91	108	79.8	94.
No Answer	6	114	5.3	100.0

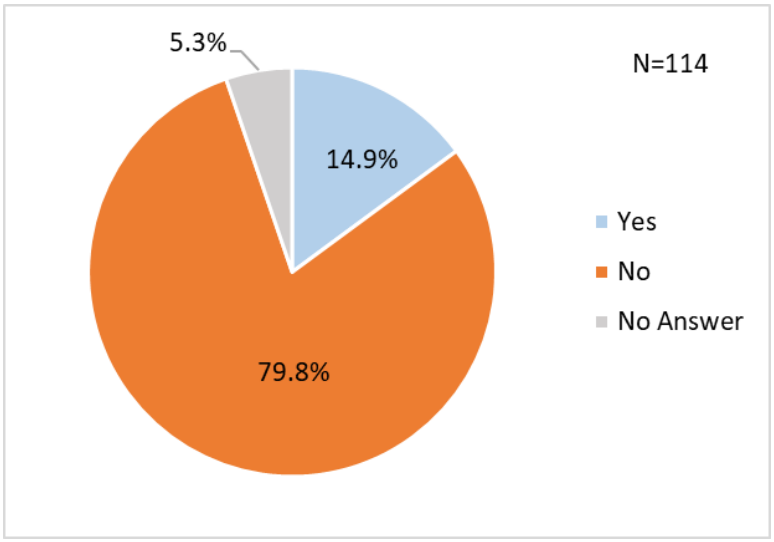


Figure C-5. Percent of panoramic units with dose index on console.

Table C-6. Panoramic Unit Dose Display by Panoramic Unit

Panoramic Unit Dose Display by Panoramic Unit	Frequency	Cumulative Frequency	Percent	Cumulative Percent
Yes	17	17	14.8	14.8
No	91	108	79.1	93.9
No Answer	7	115	6.1	100.0

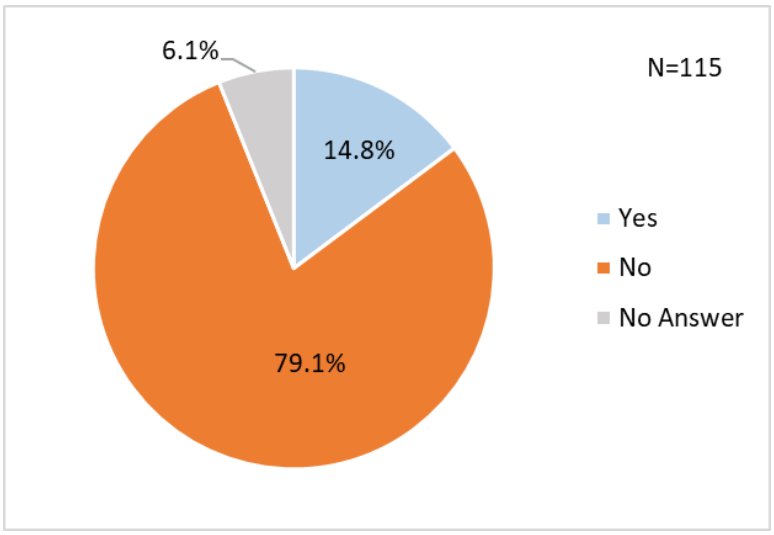


Figure C-6. Panoramic unit dose display by panoramic unit.

Table C-7. Weekly Number of Patients Receiving a Traditional Panoramic Exam (Children with Primary/Transitional Dentition, Adolescents with Permanent Dentition, and Adults) – Statistical Distribution.

Weekly Panoramic Patient Exams	N	Mean	Std. Dev.	Min	25%	Median	75%	Max
Children with Primary/Transitional Dentition	92	2.36	4.43	0	0	0.625	2.5	30
Adolescents with Permanent Dentition	90	3.66	5.14	0	1	1	5	30
Adults	109	9.4	12.82	0	2	4	10	64

Table C-8. Weekly Number of Patients Receiving a Traditional Panoramic Exam (Children with Primary/Transitional Dentition).

Number of Panoramic Exams per Week, Children with Primary/Transitional Dentition	Number	Cumulative Number	Percent	Cumulative Percent
0	44	44	47.8	47.8
1-5	35	79	38.0	85.9
6-10	10	89	10.9	96.7
11-15	2	91	2.2	98.9
15+	1	92	1.1	100.0

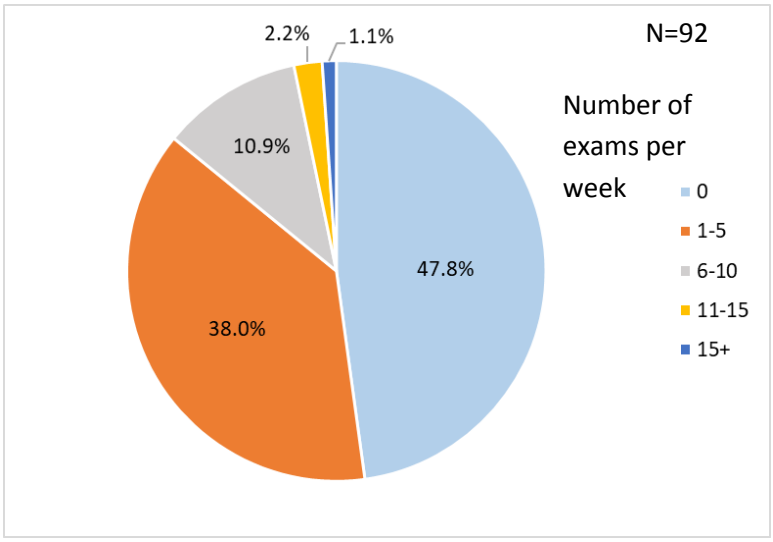


Figure C-7. Weekly number of patients receiving a traditional panoramic exam (children with primary/transitional dentition).

Table C-9. Weekly Number of Patients Receiving a Traditional Panoramic Exam (Adolescents with Permanent Dentition).

Number of Panoramic Exams per Week Adolescents with Permanent Dentition	Frequency	Cumulative Frequency	Percent	Cumulative Percent
0	20	20	22.2	22.2
1-5	51	71	56.7	78.9
6-10	15	86	16.7	95.6
11-15	1	87	1.1	96.7
15+	3	90	3.3	100.0

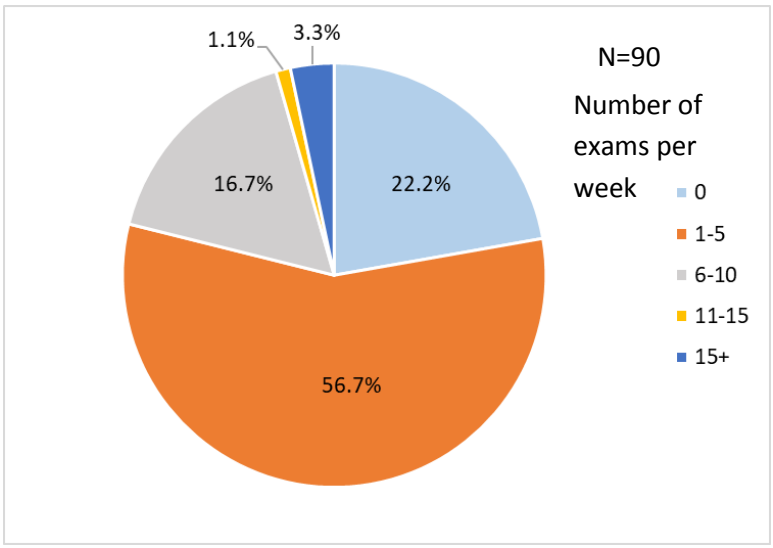


Figure C-8. Weekly number of patients receiving a traditional panoramic exam (adolescents with permanent dentition).

Table C-10. Weekly Number of Adult Patients Receiving a Traditional Panoramic Exam (Adults).

Number of Panoramic Exams per Week Adults	Number	Cumulative Number	Percent	Cumulative Percent
0	7	7	6.4	6.4
1-5	58	65	53.2	59.6
6-10	17	82	15.6	75.2
11-15	8	90	7.3	82.6
15+	19	109	17.4	100.0

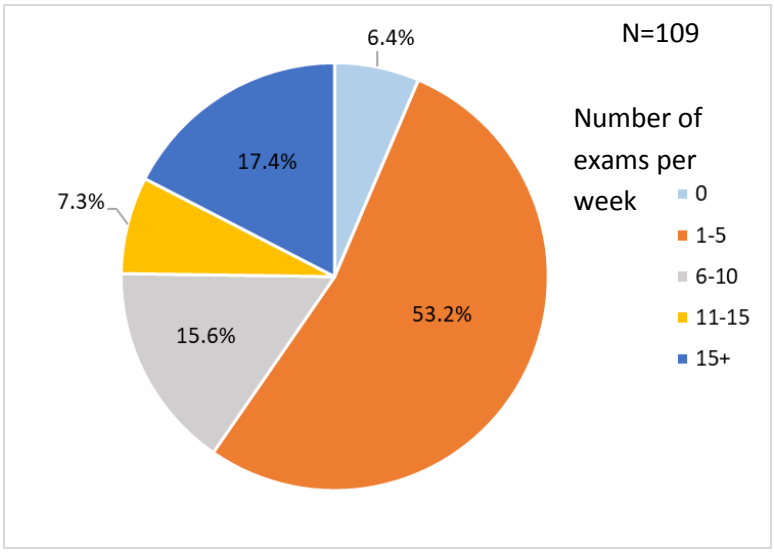


Figure C-9. Weekly number of patients receiving a traditional panoramic exam (adults).

Table C-11. Panoramic Clinical X-ray Technique Data for the Surveyed Unit (Children).

Technique Factor	N	Mean	Std. Dev.	Min	25%	Median	75%	Max
kVp	87	69.5	6.96	60	66	66	71	94
Scan Time (sec)	84	13.55	2.93	6	12	13.7	15	22
mA	85	7.7	2.6	3	6	7	9.6	16
mAs	83	102.8	40.6	36	72	96	132	225.6
Pre-exposure DAP, $mGy{\cdot}cm^2$	6	58.7	21.4	37	41	55.6	67	96

Table C-12. Panoramic Clinical X-ray Technique Data for the Surveyed Unit (Adolescents/Adults).

Technique Factor	N	Mean	Std. Dev.	Min	25%	Median	75%	Max
kVp	106	72.7	7.53	57	68	72	75	94
Scan Time (sec)	102	14.1	2.7	8.8	12	13.9	16	22
mA	105	8.3	2.9	2	6	8	10	15
mAs	101	117.6	48.4	28.2	72	113	150	225
Pre-exposure DAP, mGy·cm^2	11	103.4	54	36	48	104	123	227

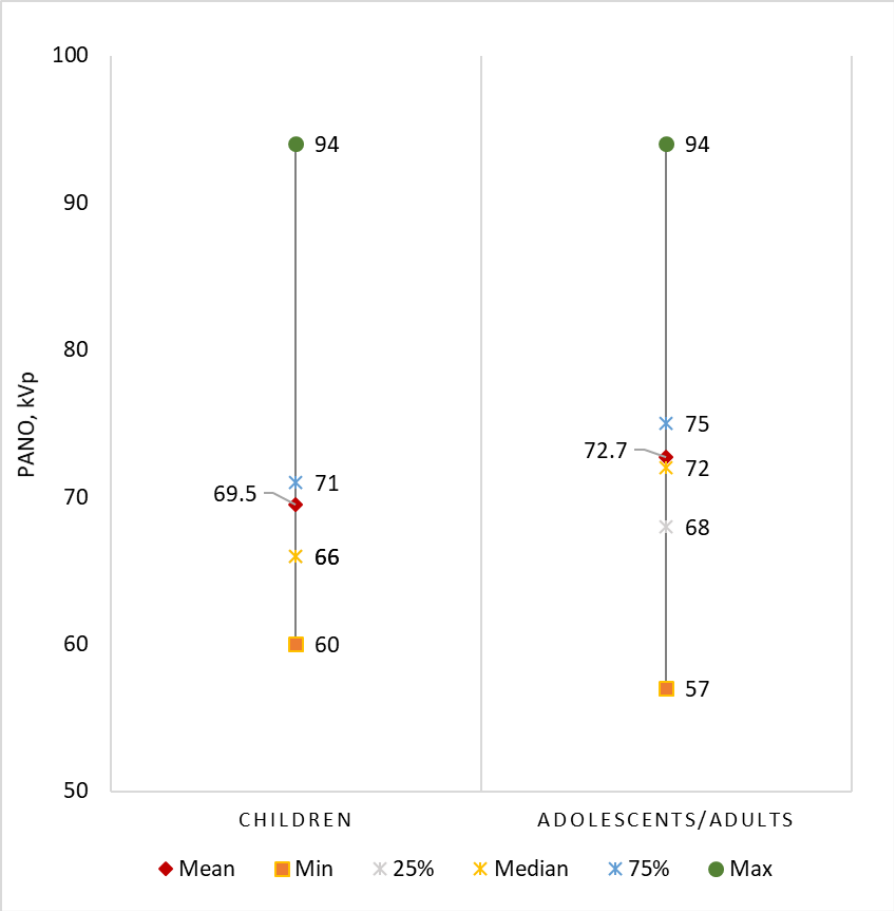


Figure C-10. Panoramic clinical x-ray technique data for the surveyed unit, kVp (children and adolescents/adults) statistical distribution.

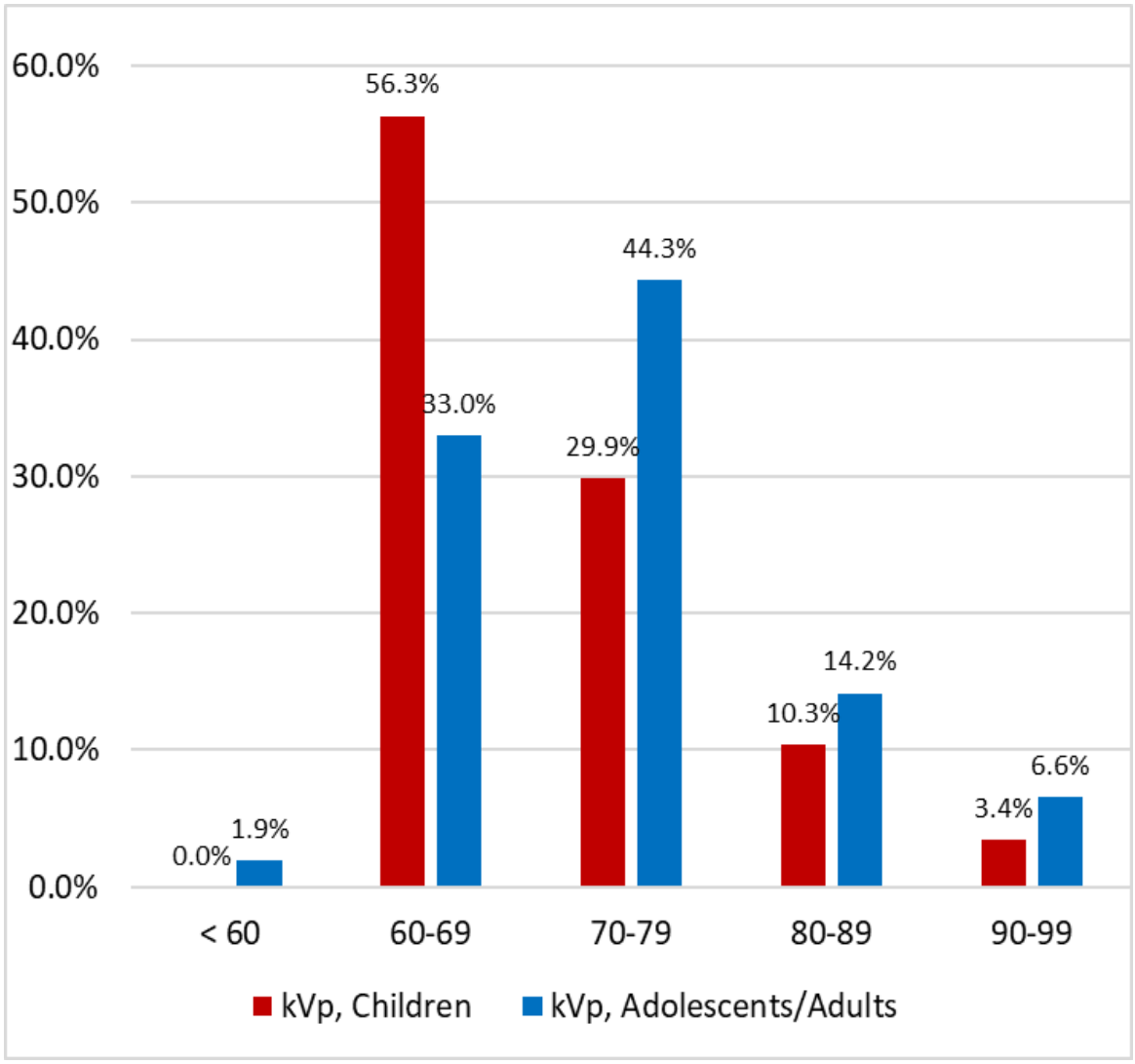


Figure C-11. Panoramic clinical x-ray technique data for the surveyed unit, kVp (children and adolescents/adults).

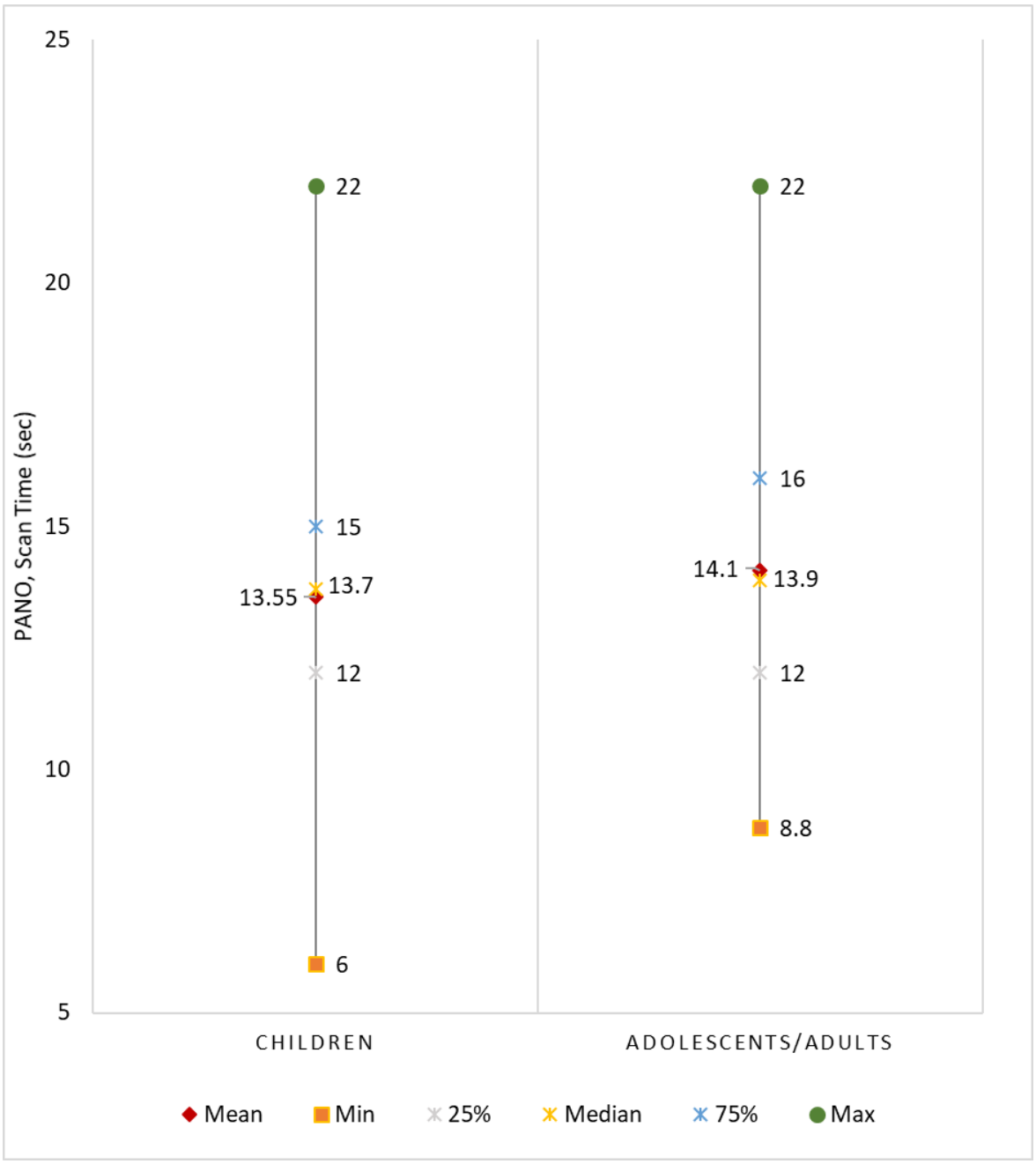


Figure C-12. Panoramic clinical x-ray technique data for the surveyed unit, scan time (sec) (children and adolescents/adults) statistical distribution.

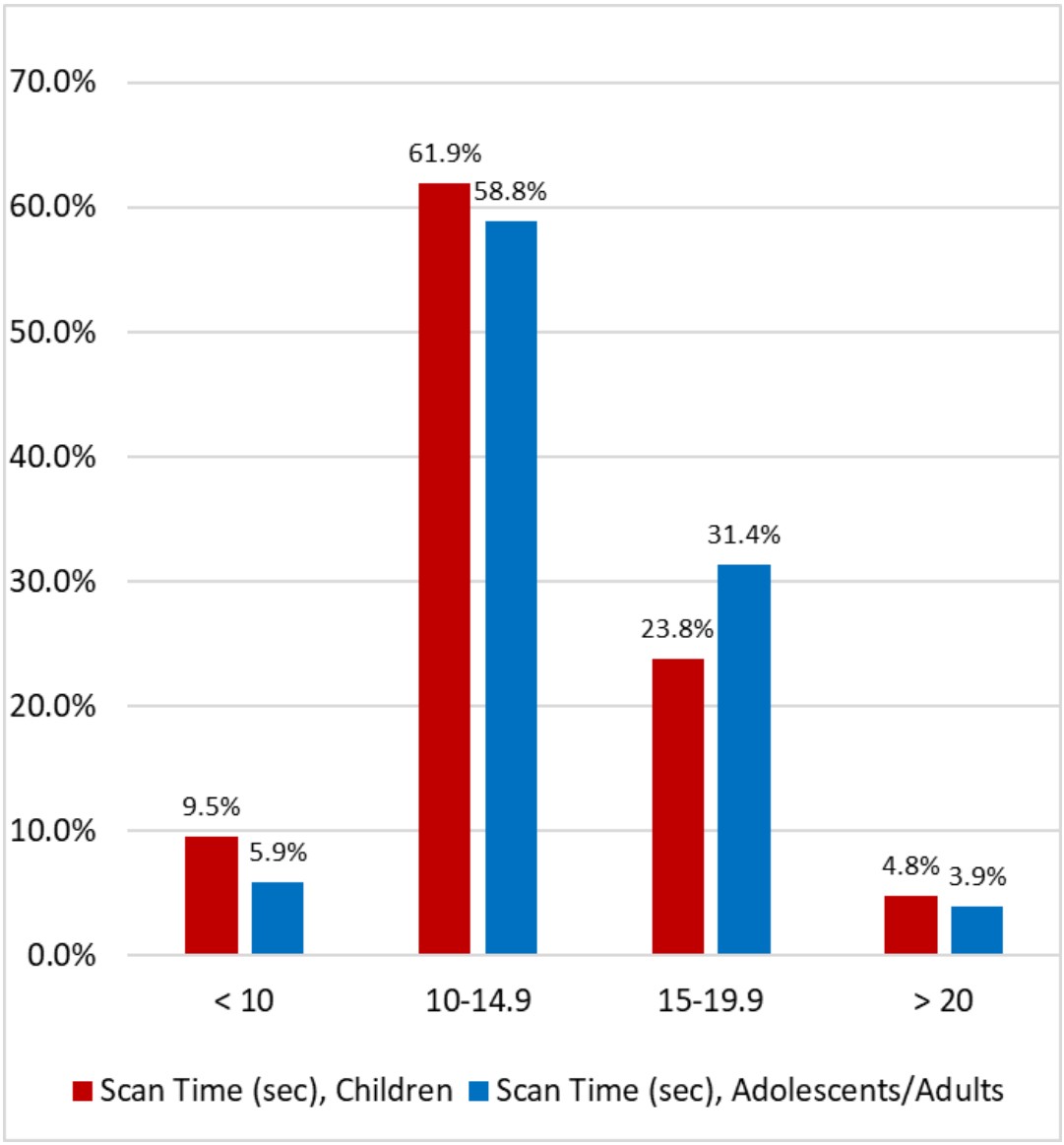


Figure C-13. Panoramic clinical x-ray technique data for the surveyed unit, scan time (sec) (children and adolescents/adults).

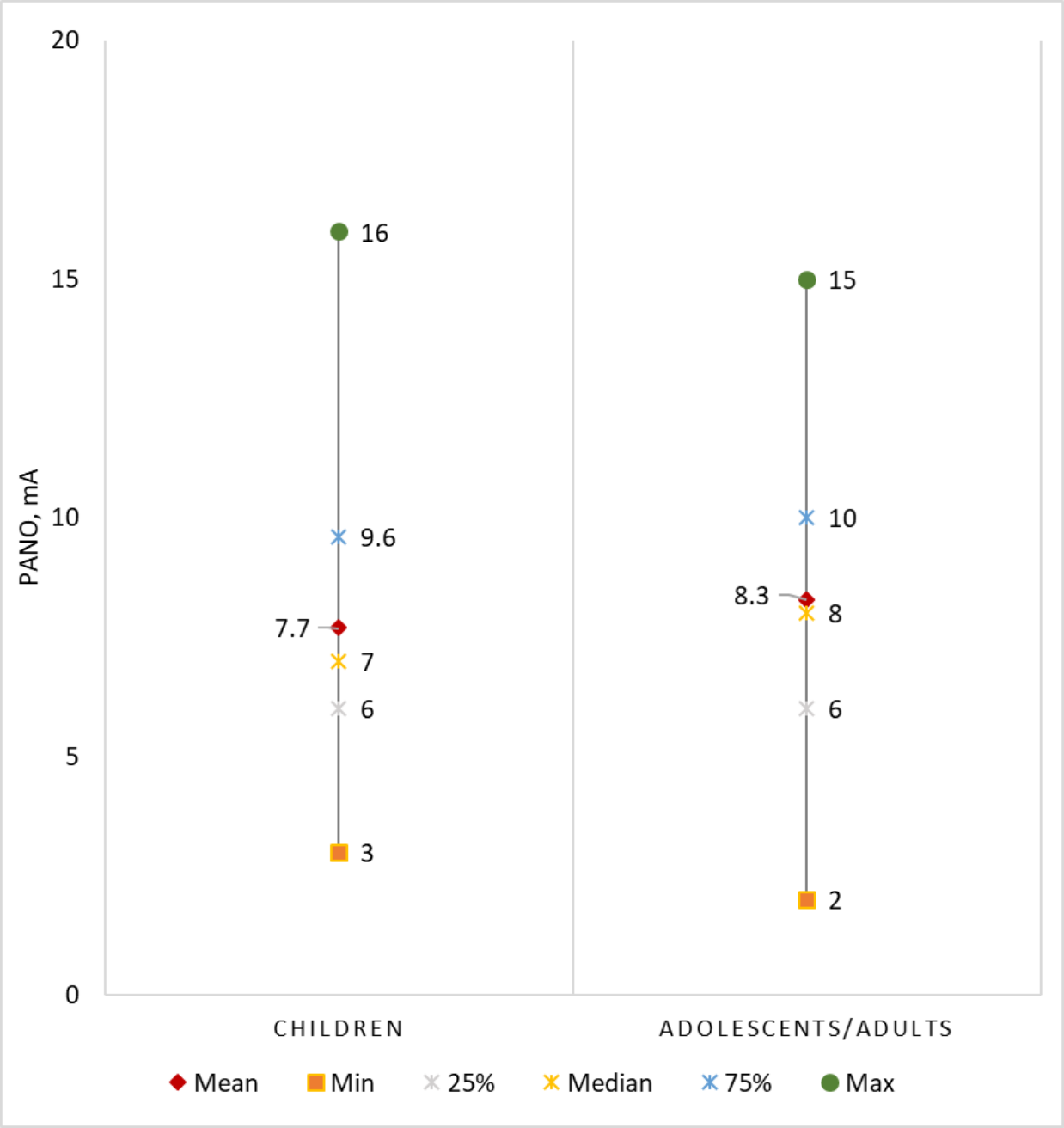


Figure C-14. Panoramic clinical x-ray technique data for the surveyed unit, mA (children and adolescents/adults) statistical distribution.

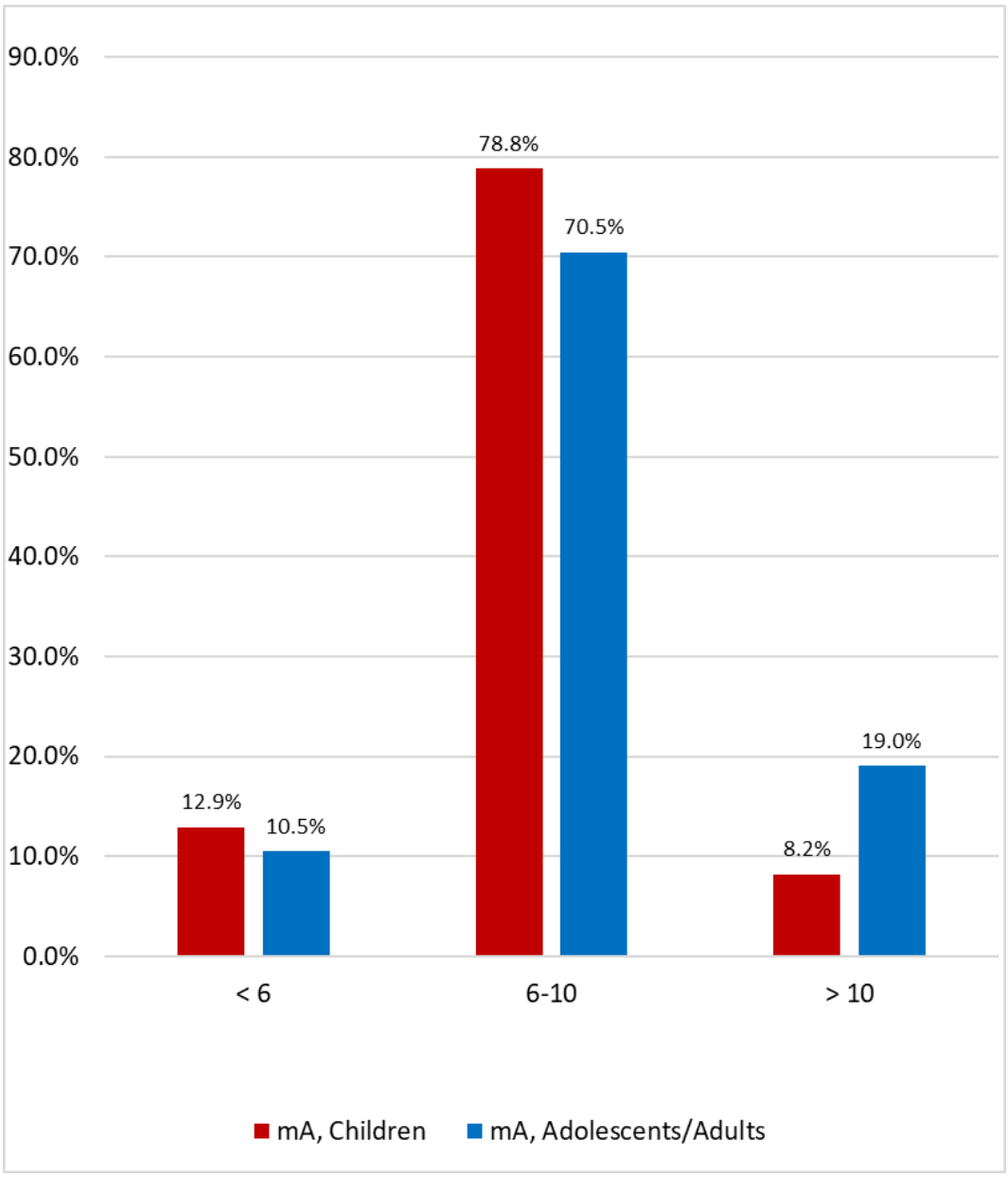


Figure C-15. Panoramic clinical x-ray technique data for the surveyed unit, mA (children and adolescents/adults).

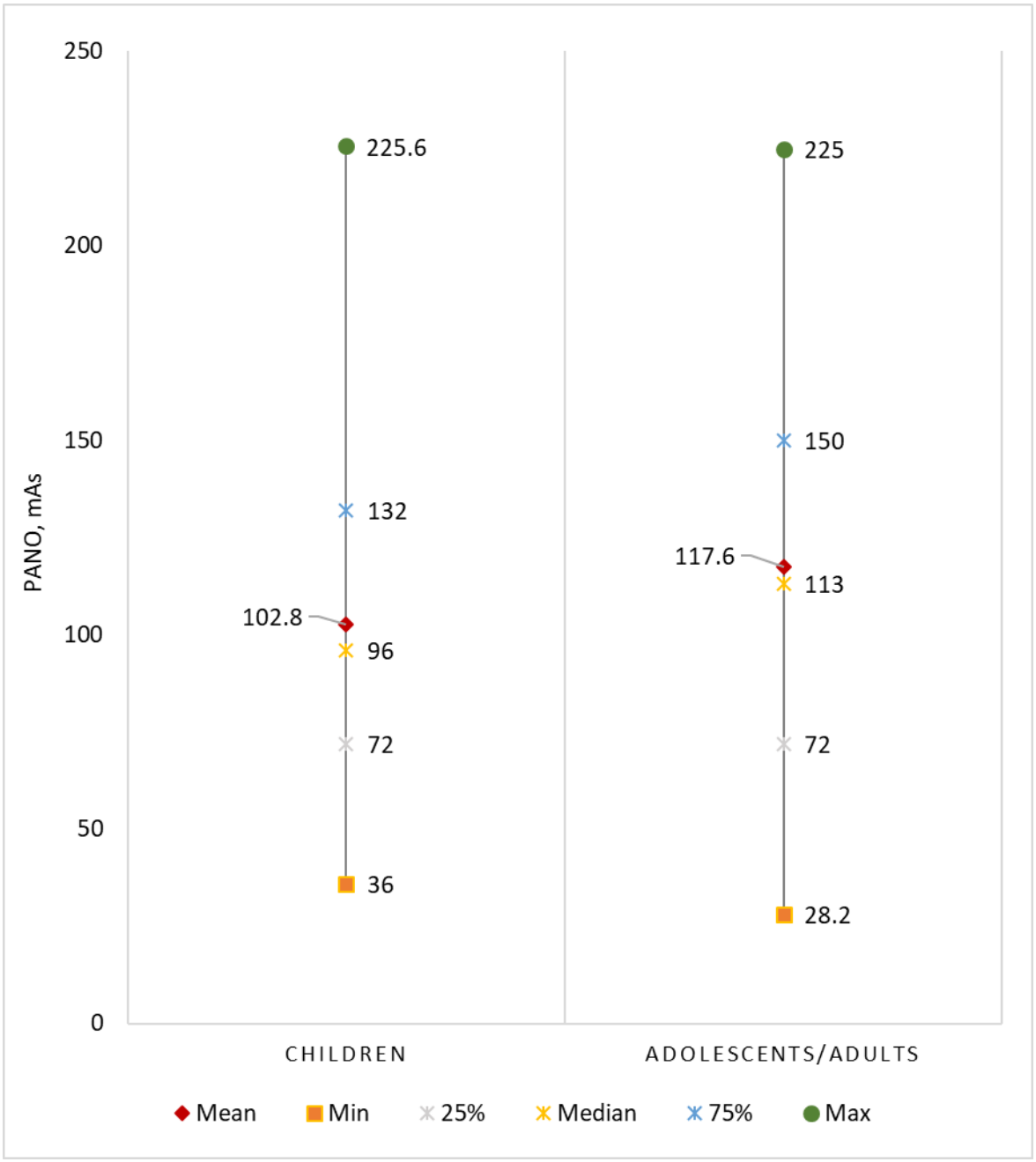


Figure C-16. Panoramic clinical x-ray technique data for the surveyed unit, mAs (children and adolescents/adults) statistical distribution.

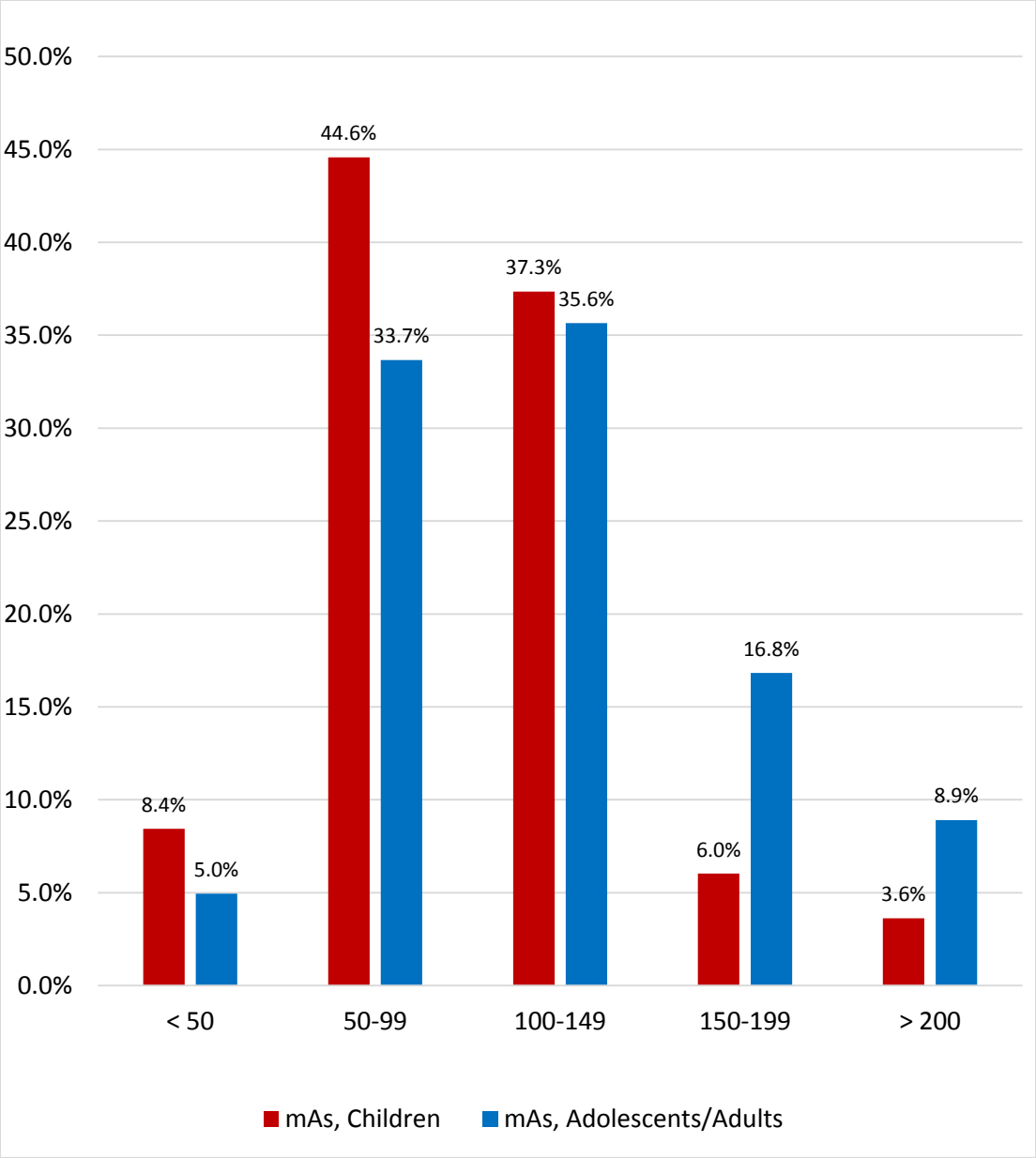


Figure C-17. Panoramic clinical x-ray technique data for the surveyed unit, mAs (children and adolescents/adults).

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APPENDIX D – CONE-BEAM COMPUTED TOMOGRAPHY PROCEDURES

Table D-1. Cone-Beam Computed Tomography Units Year of Manufacture

CBCT Year of Manufacture	Frequency	Cumulative Frequency	Percent	Cumulative Percent
< 2009	7	7	26.9	26.9
2009 - 2011	10	17	38.5	65.4
> 2011	9	26	34.6	100.0

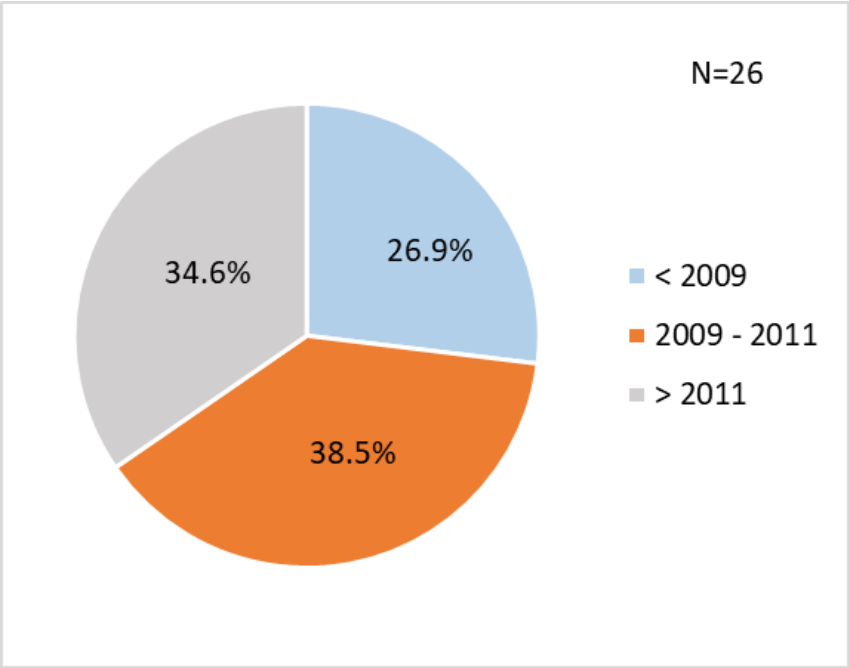

Figure D-1. Percent of cone-beam computed tomography units by year of manufacture.

Table D-2. Cone-Beam Computed Tomography Certification Label

CBCT Certification Label	Frequency	Cumulative Frequency	Percent	Cumulative Percent
Yes	23	23	85.2	85.2
No	4	27	14.8	100.0
No Answer	0	27	0.0	100.0

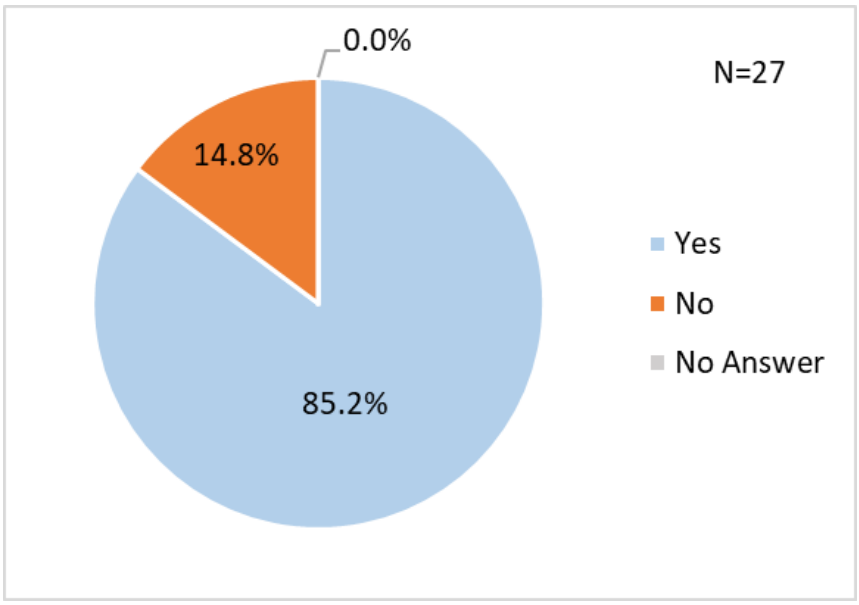

Figure D-2. Percent of cone-beam computed tomography units with certification label.

All surveyed responded to this question; therefore, "no answer" is represented by 0.0% in this chart.

Table D-3. Weekly Number of CBCT Patients Examined per Week at Each Facility for the Surveyed Unit (Children, Adolescents, Adults) - Descriptive Statistics.

Weekly CBCT Patient Exams	N	Mean	Std. Dev.	Min	25%	Median	75%	Max
Children	21	1.1	1.6	0	0	0	2	5
Adolescents	21	2.9	3.1	0	1	2	3	10
Adults	28	10.1	10.9	0	2	6.5	15	48

Table D-4. Number of CBCT Exams Taken During Entire Orthodontic Treatment - Descriptive Statistics.

Weekly CBCT Patient Exams	N	Mean	Std. Dev.	Min	25%	Median	75%	Max
Orthodontic Treatment	16	1.8	1.3	0	1	2	2.5	4

Table D-5. Number of CBCT Exams per Week (Children).

Number of CBCT Exams per Week Children	Number	Cumulative Number	Percent	Cumulative Percent
0	12	12	57.1	57.1
1	3	15	14.3	71.4
2	2	17	9.5	81.0
3	2	19	9.5	90.5
4	0	19	0.0	90.5
5+	2	21	9.5	100.0

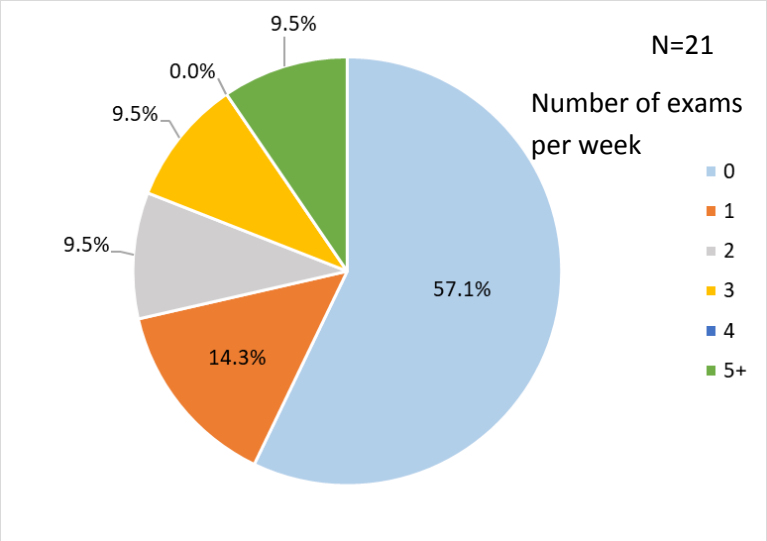

Figure D-3. Number of CBCT exams per week (children).

No instances of 4 exams per week were reported, as shown as 0.0% on the chart.

Table D-6. Number of CBCT Exams per Week (Adolescents).

Number of CBCT Exams per Week Adolescents	Number	Cumulative Number	Percent	Cumulative Percent
0	4	4	19.0	19.0
1	4	8	19.0	38.1
2	6	14	28.6	66.7
3	2	16	9.5	76.2
4	1	17	4.8	81.0
5+	4	21	19.0	100.0

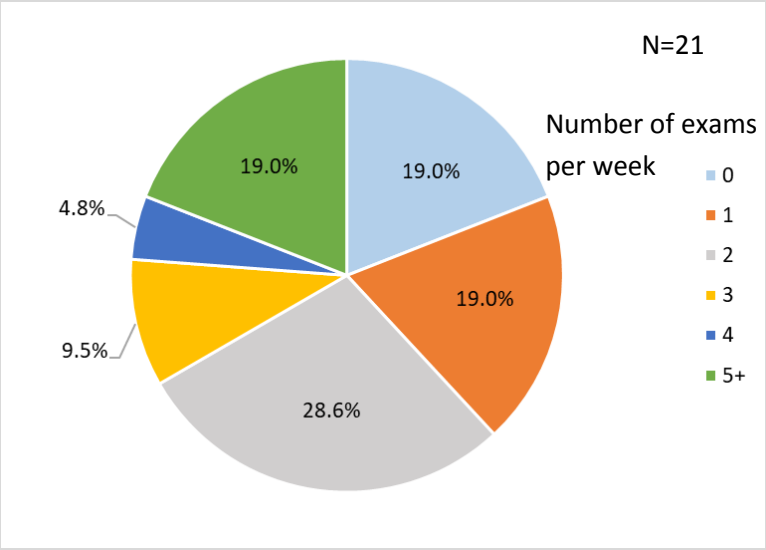

Figure D-4. Number of CBCT exams per week (adolescents).

Table D-7. Number of CBCT Exams per Week (Adults).

Number of CBCT Exams per Week Adults	Number	Cumulative Number	Percent	Cumulative Percent
0	1	1	3.6	3.6
1	4	5	14.3	17.9
2	4	9	14.3	32.1
3	0	9	0.0	32.1
4	2	11	7.1	39.3
5+	17	28	60.7	100.0

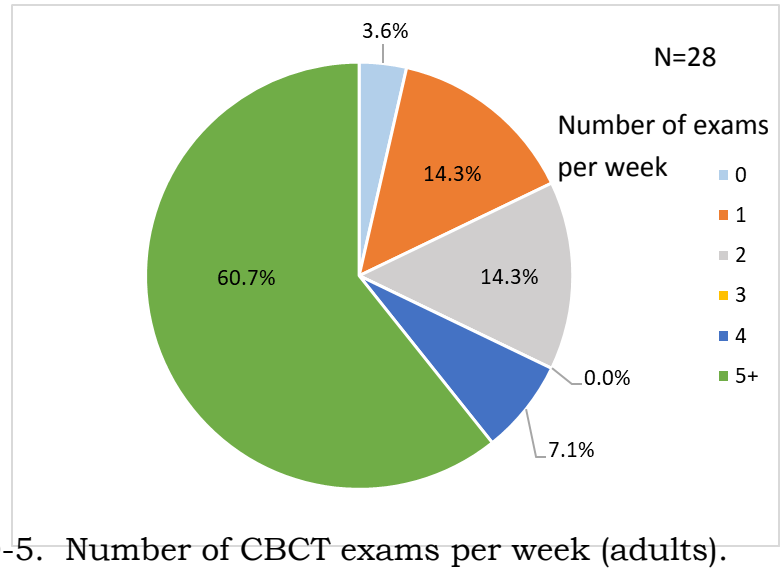

Figure D-5. Number of CBCT exams per week (adults).

No instances of 3 exams per week were reported, as shown as 0.0% on the chart.

Table D-8. CBCT Clinical X-ray Technique Data for the Surveyed Unit, (Children) – Descriptive Statistics.

	N	Mean	Std. Dev.	Min	25%	Median	75%	Max
kVp	13	99.5	21.6	64	84	98	120	120
Scan Time (sec)	10	7.97	3.5	4	4.8	7.45	10	15
mA	9	6.83	4.6	3	4.6	6	7	18.5
mAs	11	41.2	46.5	10	14	20	69	165
Pre-exposure DAP, $mGy{\cdot}cm^2$	6	575	636	65	188	384	624	1806

Table D-9. CBCT Clinical X-ray Technique Data for the Surveyed Unit, (Adolescents/Adults) – Descriptive Statistics.

	N	Mean	Std. Dev.	Min	25%	Median	75%	Max
kVp	26	100.6	18.4	72	85	94	120	120
Scan Time	21	12.5	6.5	3.7	8.9	11.3	15	26.9
mA	18	8	4.1	3.7	5	6.2	10	18.5
mAs	22	62.3	51.6	2.8	18.5	44.5	101	165
Pre-exposure DAP, $mGy{\cdot}cm^2$	9	827	653	218	583	624	727	2497

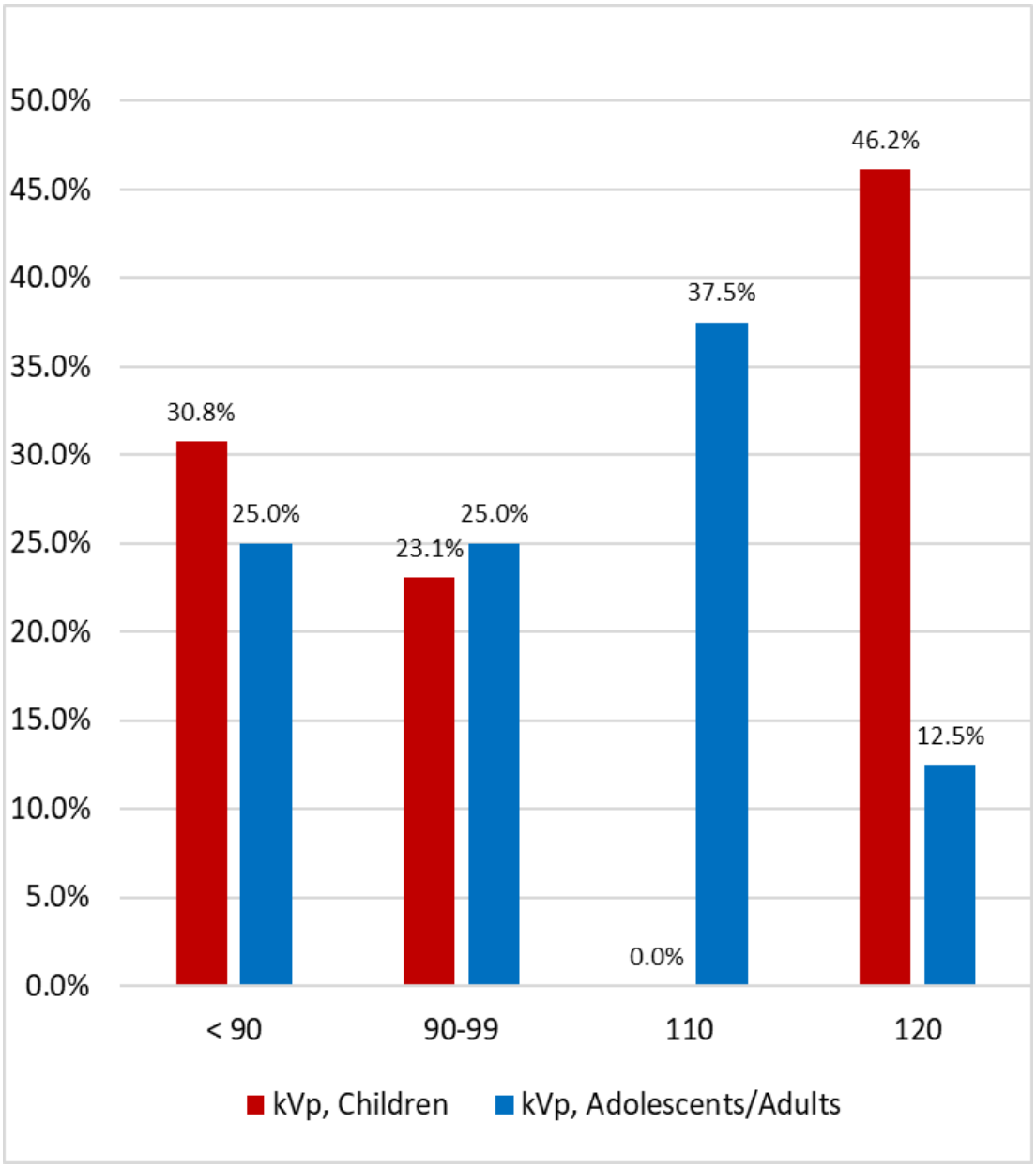

Figure D-6. CBCT clinical x-ray technique data for the surveyed unit, kVp (children and adolescents/adults).

See data in Tables D-8 and D-9.

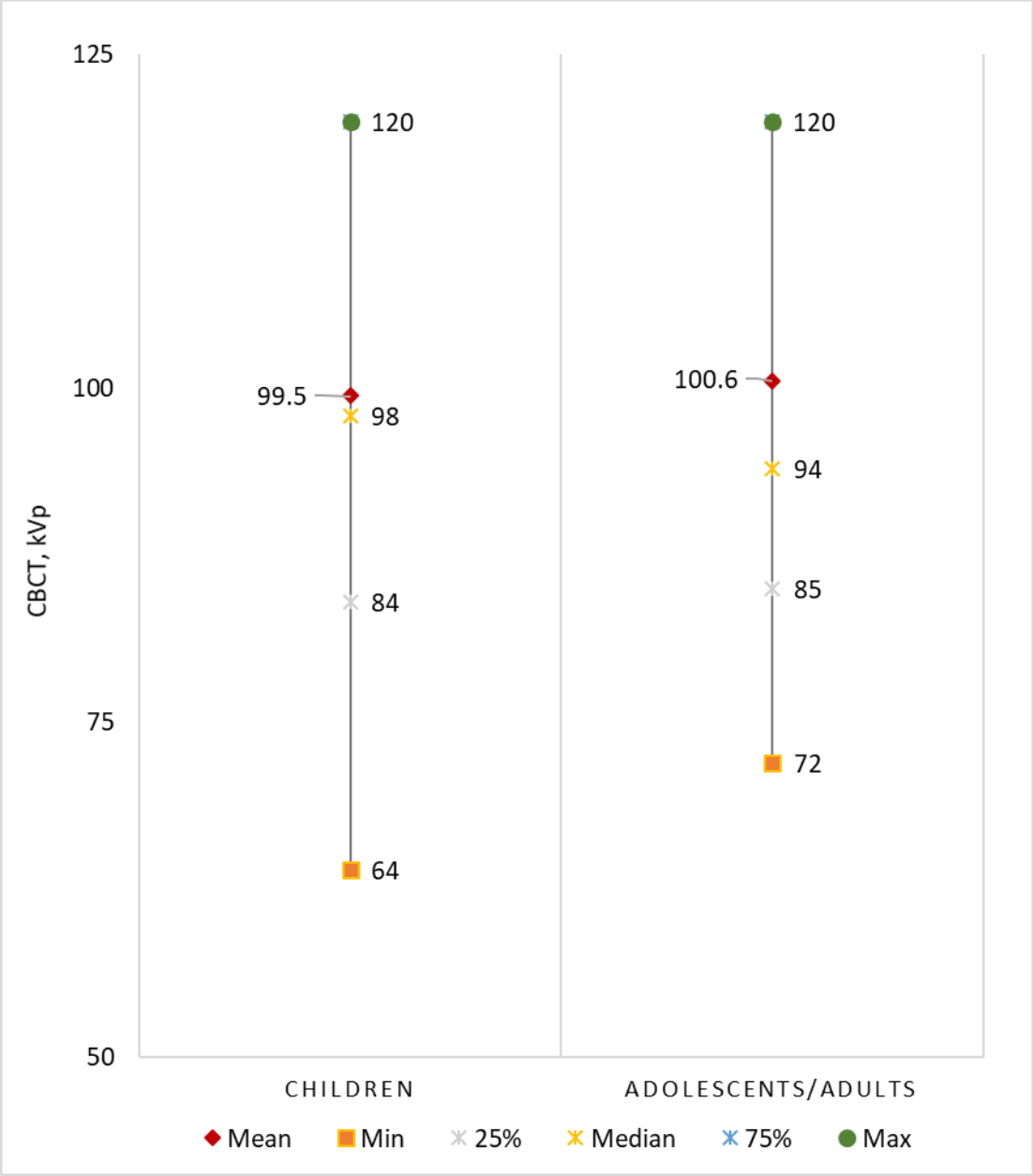

Figure D-7. CBCT clinical x-ray technique data for the surveyed unit, kVp (children and adolescents/adults).

See data in Tables D-8 and D-9.

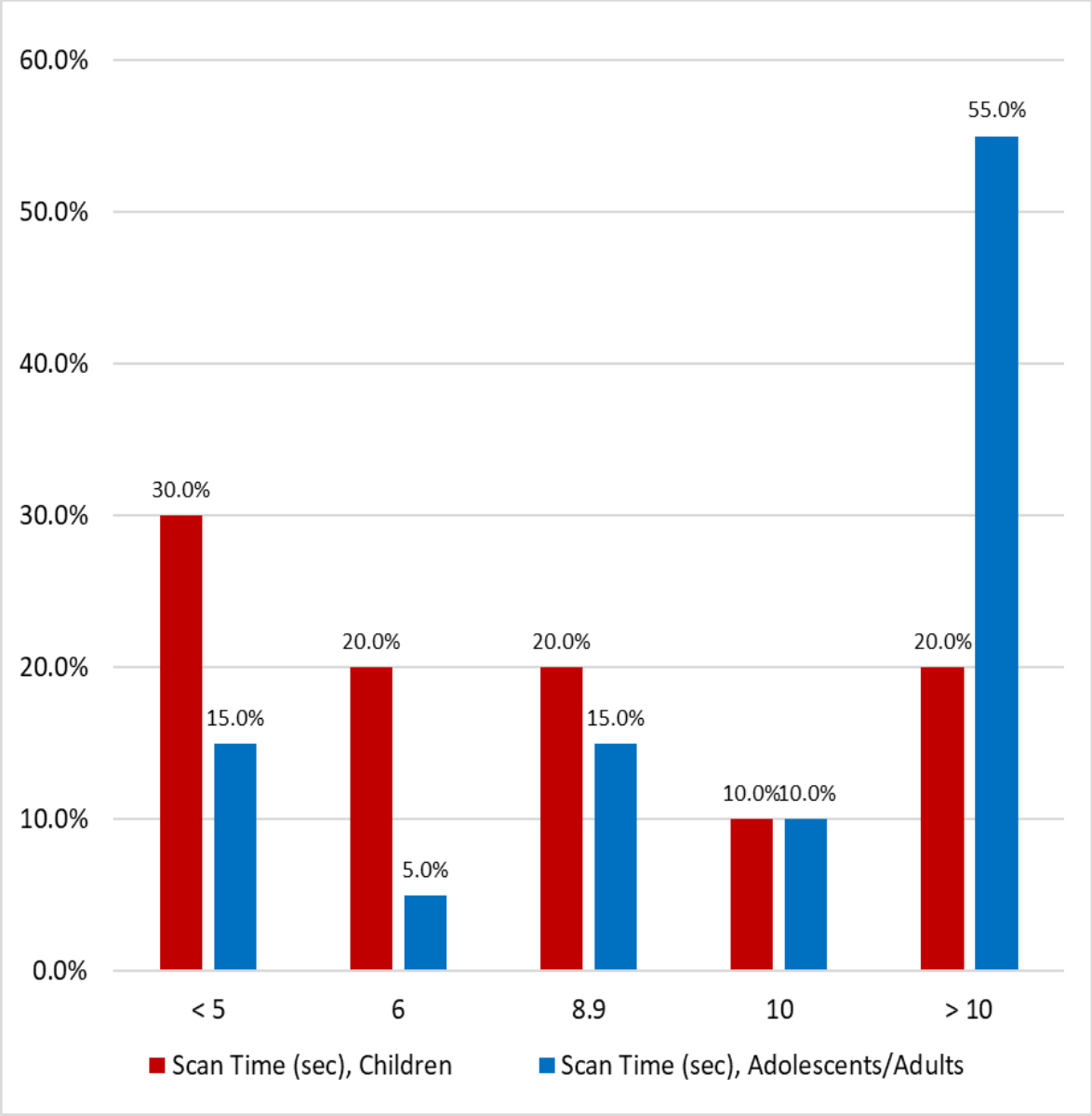

Figure D-8. CBCT clinical x-ray technique data for the surveyed unit, scan time (sec)(children and adolescents/adults).

See data in Tables D-8 and D-9.

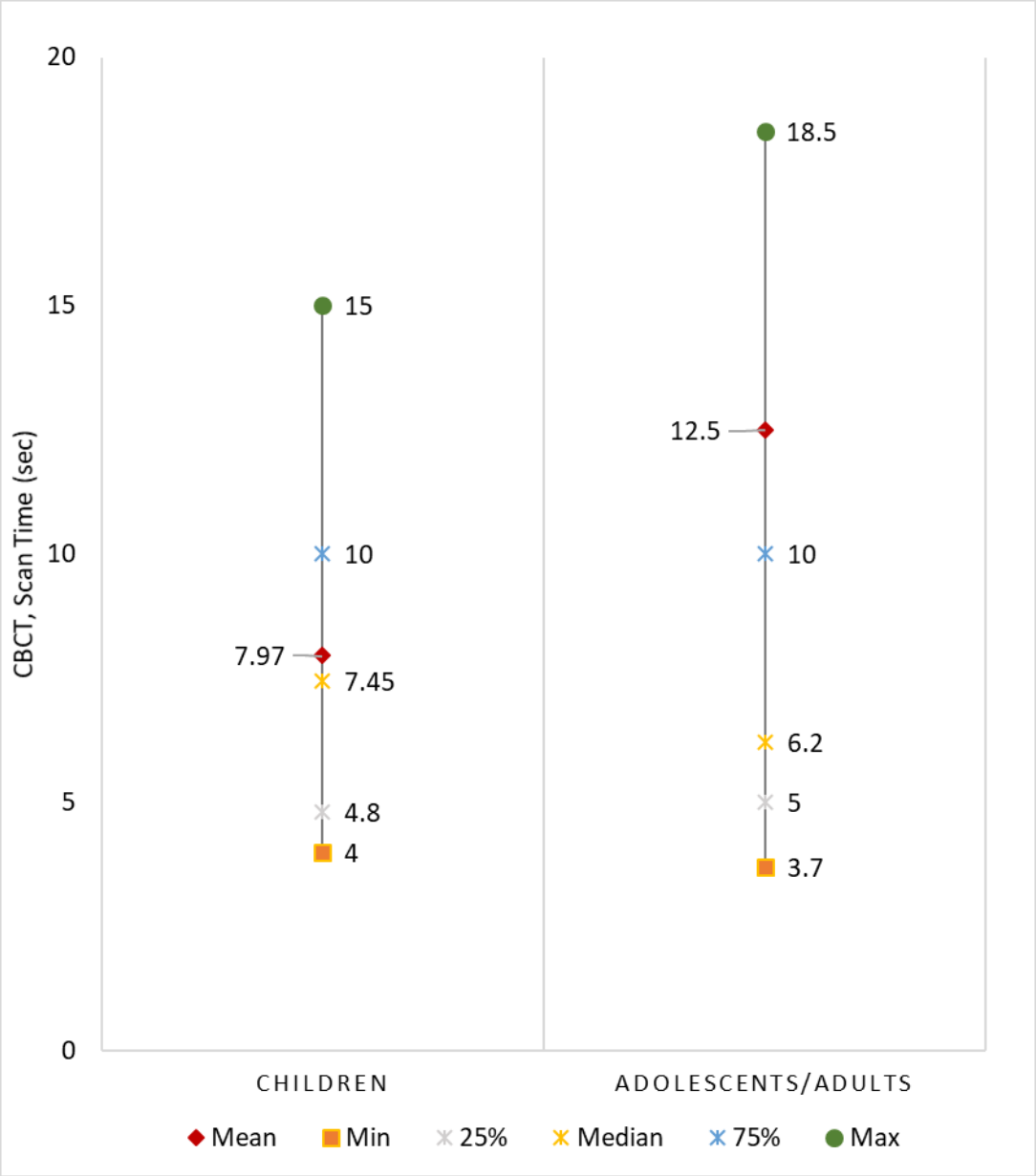

Figure D-9. CBCT clinical x-ray technique data for the surveyed unit, scan time (sec) (children and adolescents/adults).

See data in Tables D-8 and D-9.

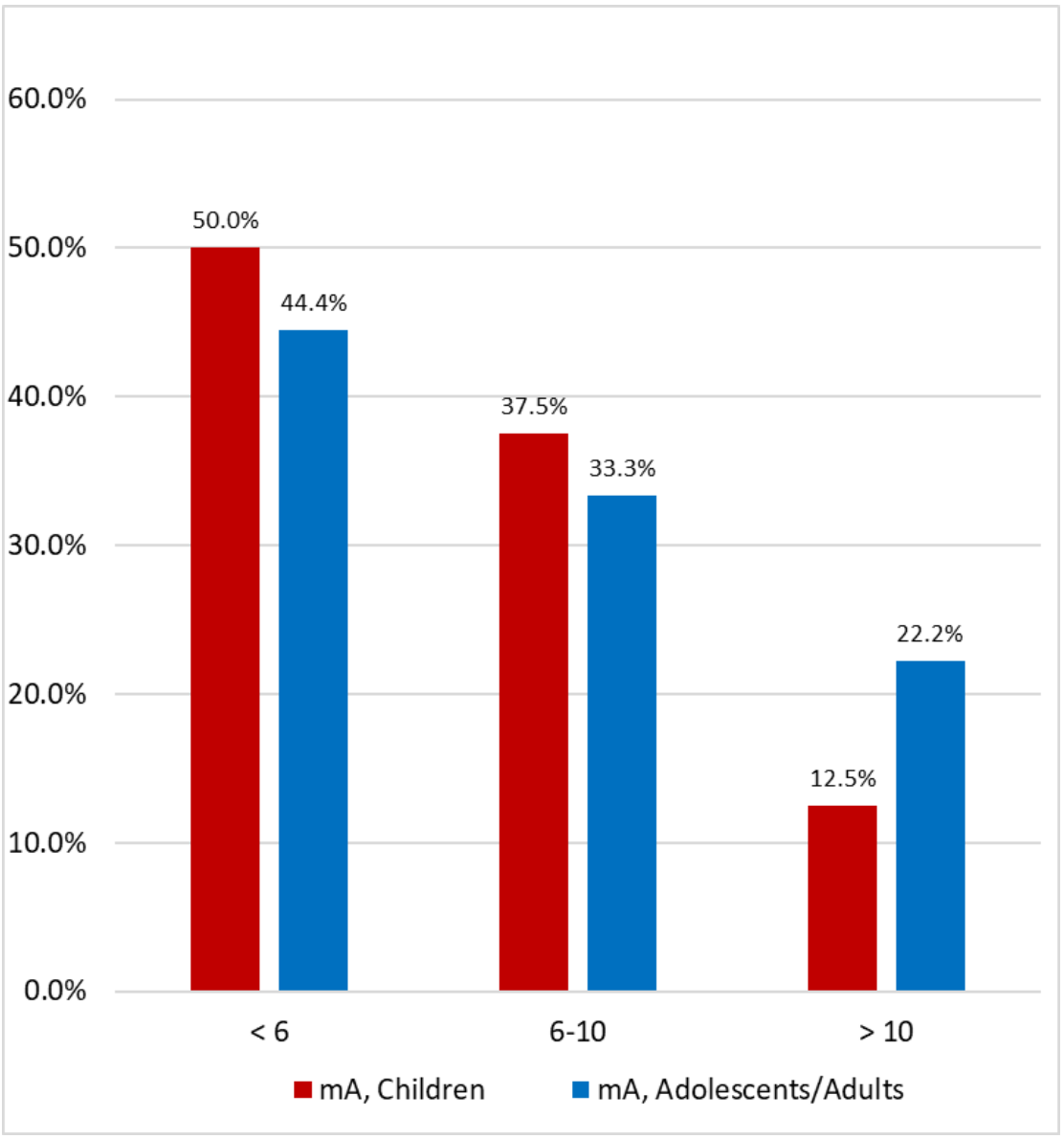

Figure D-10. CBCT clinical x-ray technique data for the surveyed unit, mA (children and adolescents/adults).

See data in Tables D-8 and D-9.

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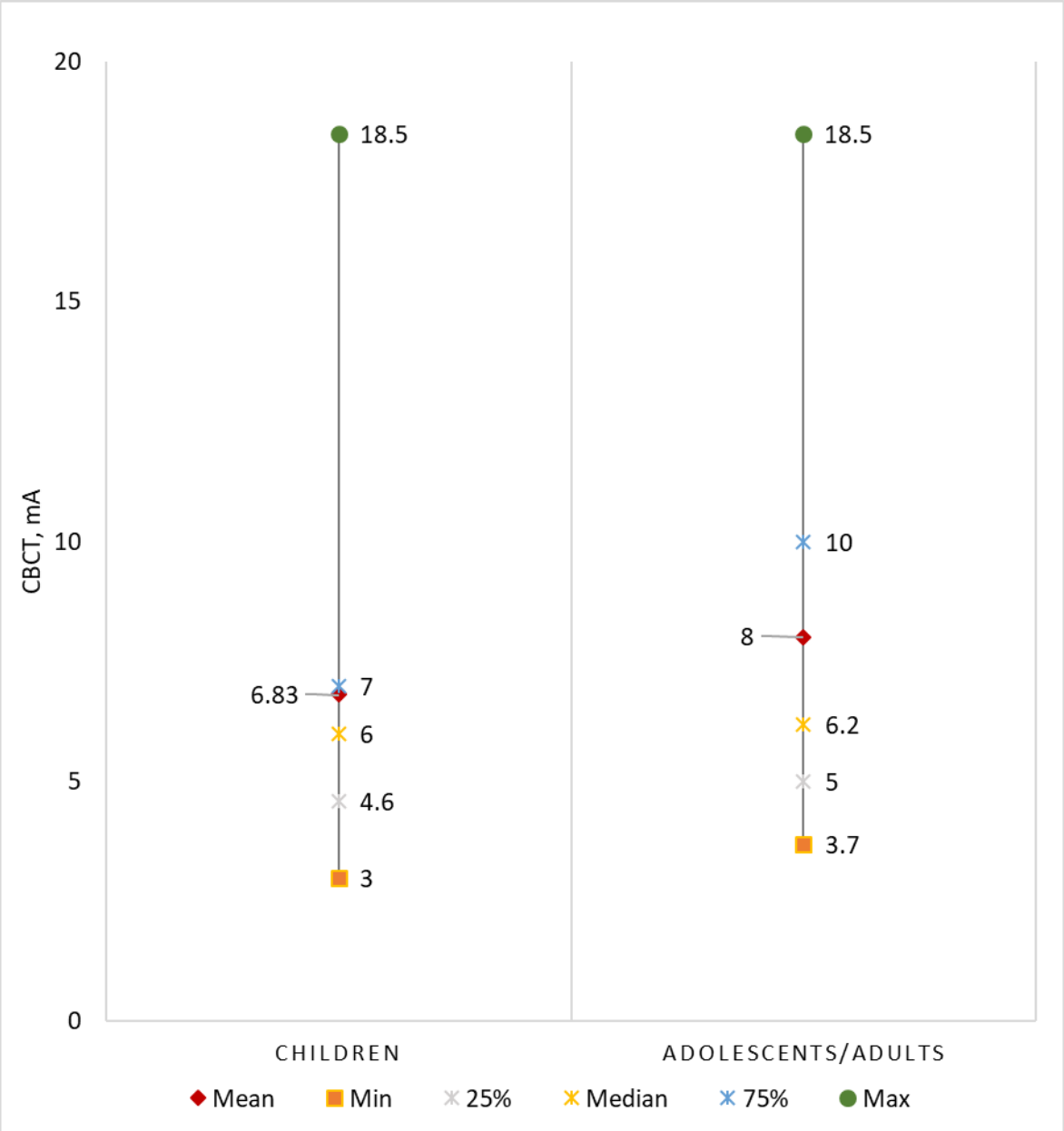

Figure D-11. CBCT clinical x-ray technique data for the surveyed unit, mA (children and adolescents/adults).

See data in Tables D-8 and D-9.

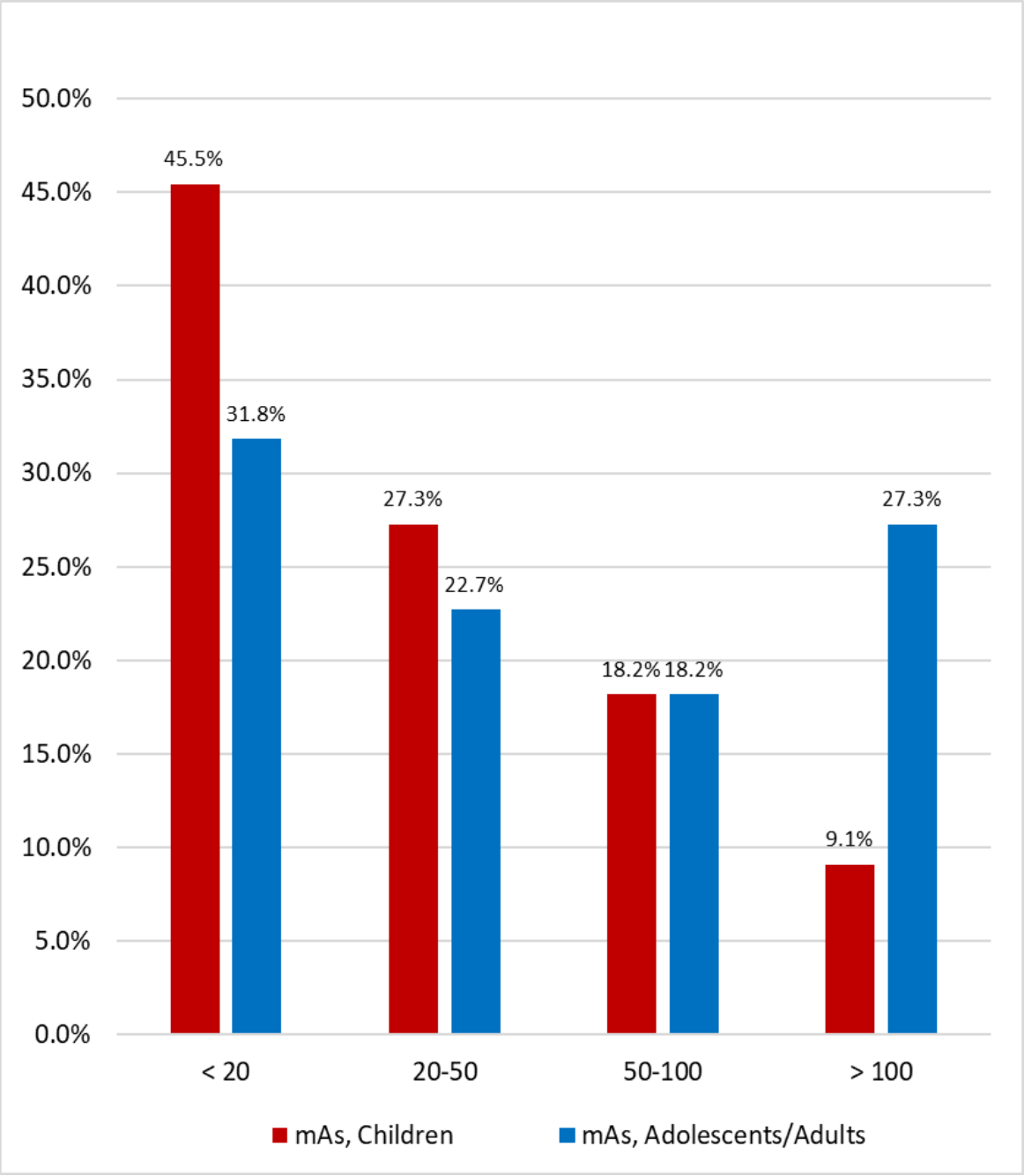

Figure D-12. CBCT clinical x-ray technique data for the surveyed unit, mAs (children and adolescents/adults).

See data in Tables D-8 and D-9.

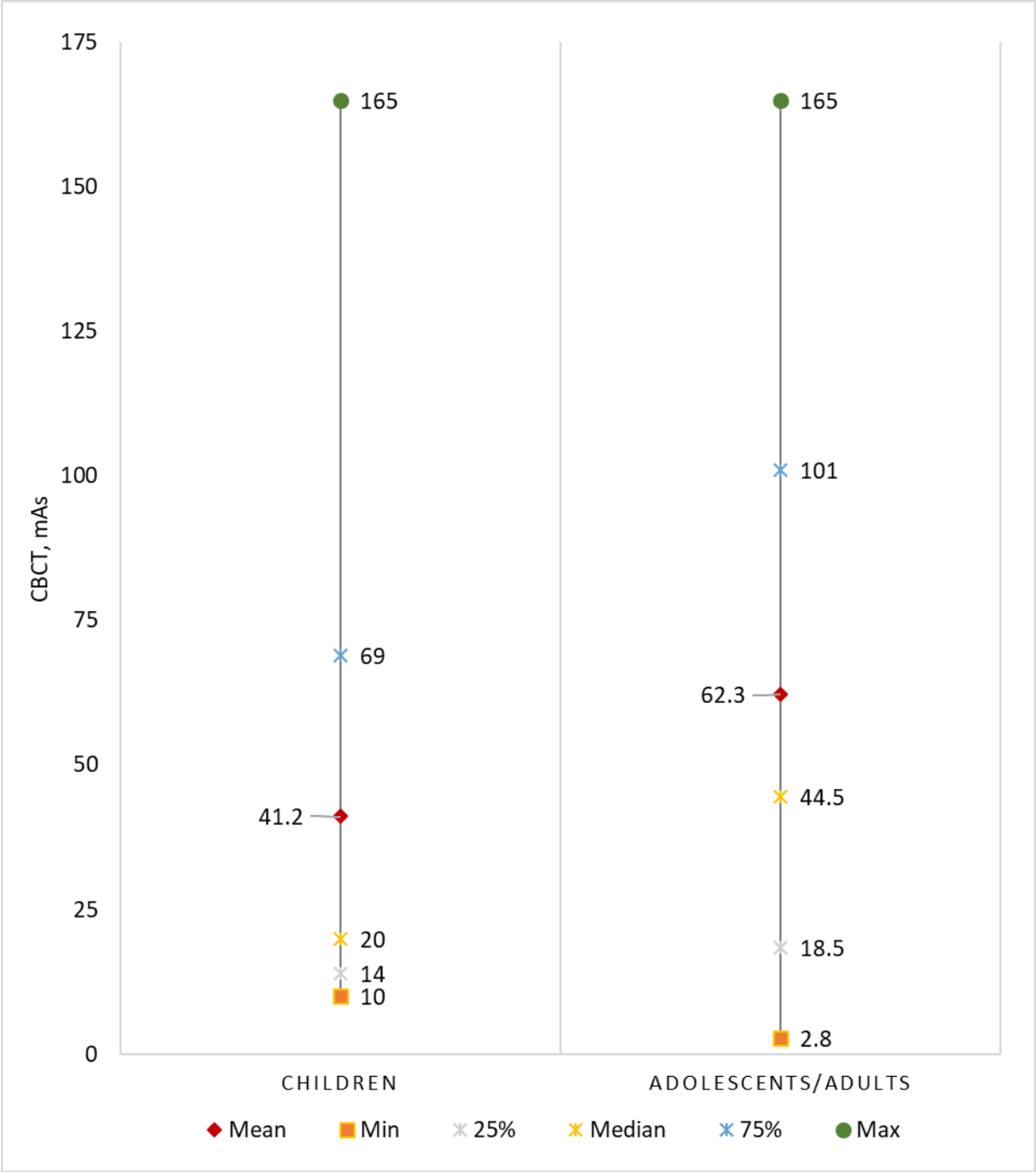

Figure D-13. CBCT clinical x-ray technique data for the surveyed unit, mAs (children and adolescents/adults).

See data in Tables D-8 and D-9.

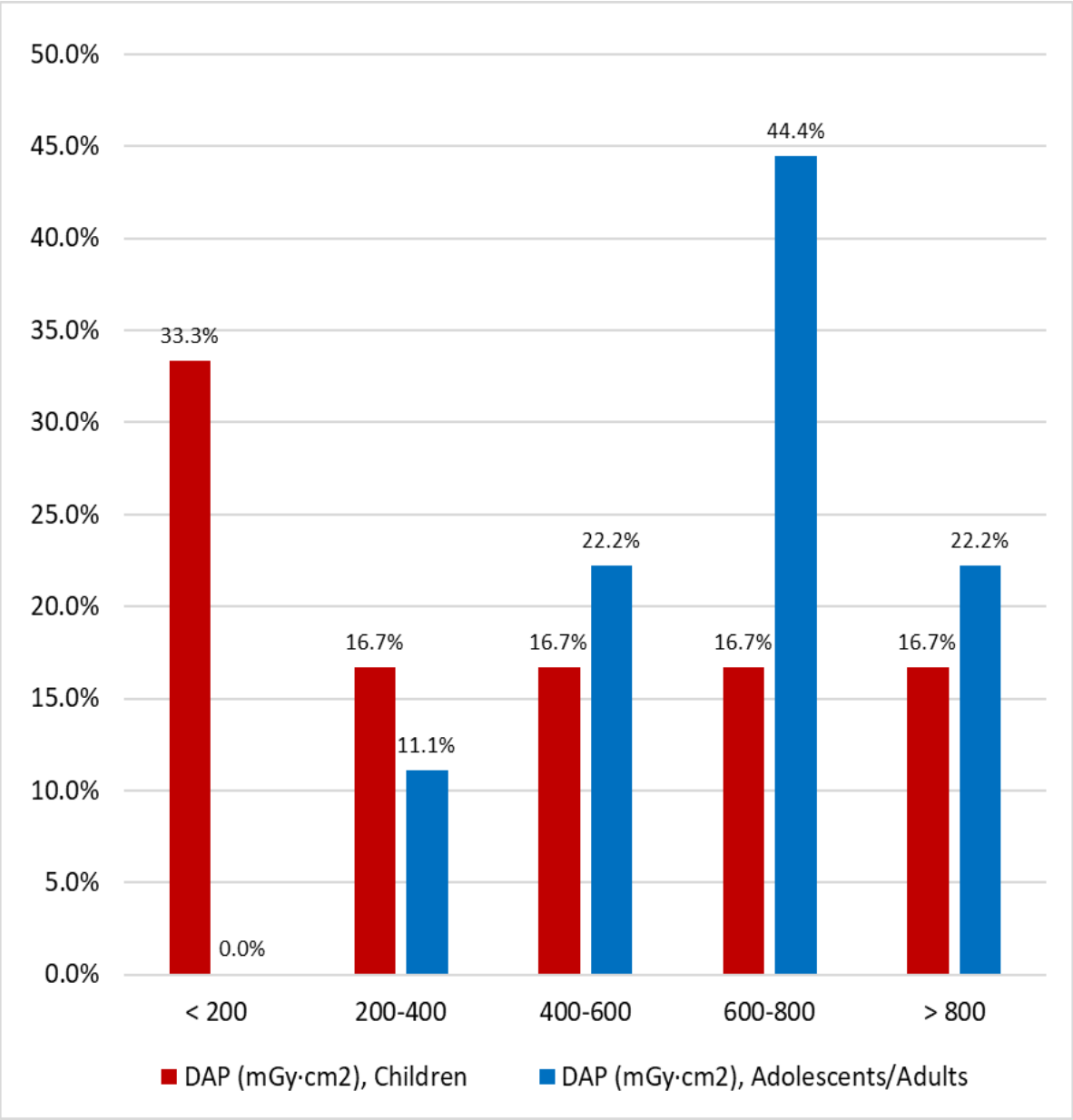

Figure D-14. CBCT clinical x-ray technique data for the surveyed unit, dose area product (DAP) (mGy·cm^2) (children and adolescents/adults).

See data in Tables D-8 and D-9.

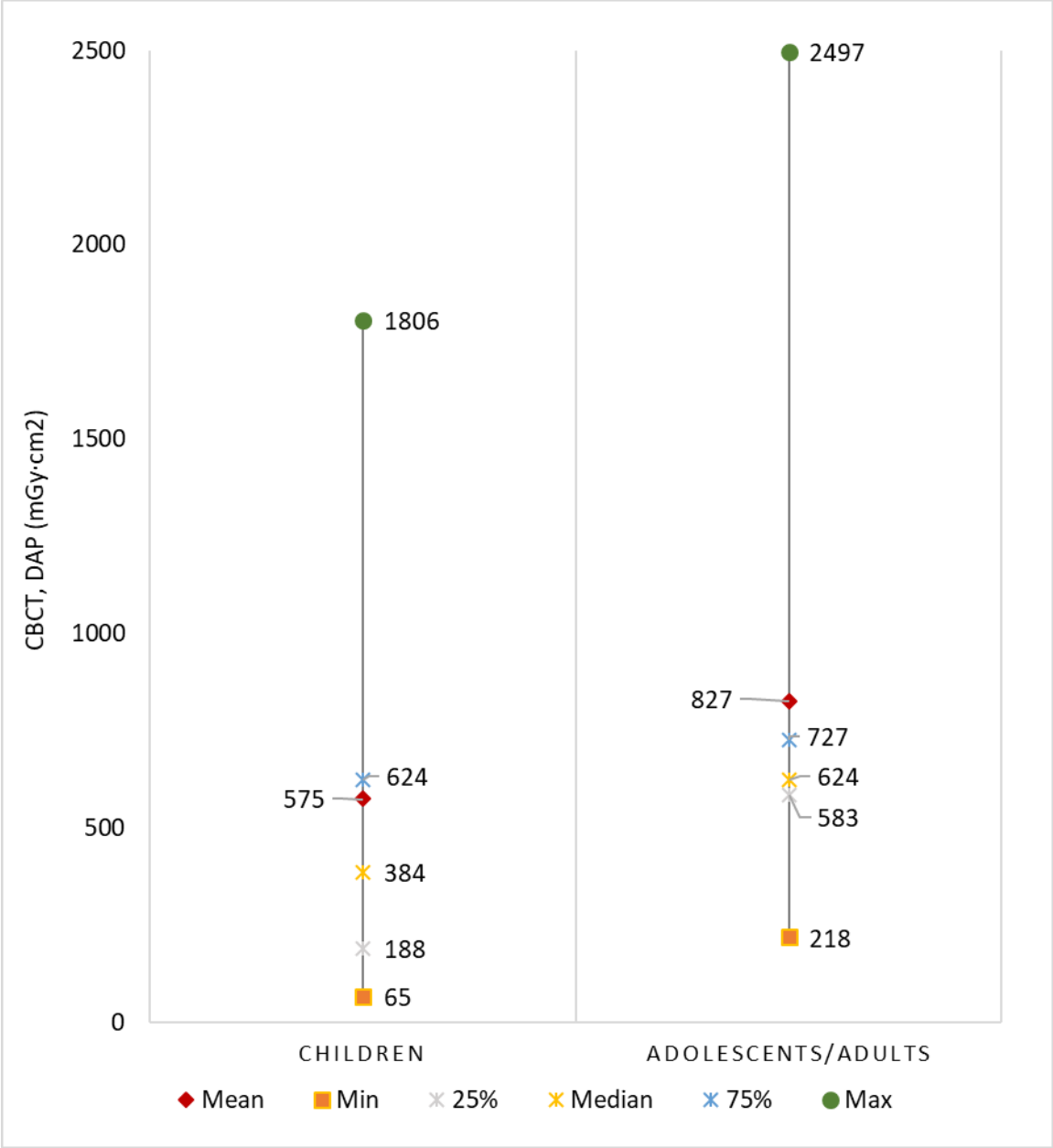

Figure D-15. CBCT clinical x-ray technique data for the surveyed unit, dose area product, (DAP) (mGy·cm^2) (children and adolescents/adults).

See data in Tables D-8 and D-9.