

Patient Dose Assessment and Diagnostic Reference Levels in Routine Adult PA Chest Radiography: A Narrative Review

Mohammed Dhehyaa Shareef ¹, Layth Yousif Jebur ², Mohammed Wael Mohammed Mohammed ³

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^{1,2,3} Radiology Techniques Department, College of Medical Technology, The Islamic University, Najaf, Iraq

* Corresponding author email: Mohammed0781@iunajaf.edu.iq

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ABSTRACT

Background: Diagnostic reference levels (DRLs) support dose optimisation, but differences in patient selection, technology and dosimetry complicate comparisons in adult posteroanterior (PA) chest radiography. **Purpose:** To provide a focused, method-aware synthesis of published reference values and their practical interpretation. **Methods:** The existing narrative evidence base was supplemented on 6 October 2026 by targeted web searches for PubMed/PMC records, publisher pages and official radiation-protection guidance. Recent evidence published from January 2020 to the search date was prioritised, with earlier foundational guidance retained. Projection, patient size, detector technology, dose quantity, measurement approach and statistical basis were extracted where accessible. **Results:** Selected studies reported surface-dose/kerma reference values of 0.20–0.68 mGy, which are not automatically equivalent quantities. PA chest kerma-area-product values included 51 mGy·cm² in Dubai, 77 mGy·cm² in the UK and 769.23 mGy·cm² in the Korean equipment survey. These differences cannot be interpreted as a ranking because the studies differ in sampling, dosimetry and reference-level derivation. **Conclusion:** The practical contribution is a comparability checklist and an investigation pathway linking dose variation to patient size, equipment, exposure technique, measurement uncertainty and diagnostic image quality. DRLs should guide group-level investigation and iterative optimisation, rather than serve as individual patient limits or universal dose targets.

1. Introduction

Chest radiography remains one of the most widely used diagnostic imaging examinations because of its broad clinical availability, rapid acquisition, relatively low radiation exposure (a typical PA chest examination delivers an effective dose of the order of 0.02 mSv or less [23]), and usefulness in the assessment of pulmonary, cardiac, and other thoracic abnormalities. Because very large numbers of examinations are performed, systematic optimisation of radiation exposure remains an important component of radiological protection even for this low-dose procedure. The International Commission on Radiological Protection (ICRP) defines a diagnostic reference level (DRL) as a form of investigation level used as a tool to aid optimisation of protection in medical exposures [1]. DRLs are associated with a defined examination, clinical or technical condition, patient population, and dosimetric quantity. For national DRLs, ICRP recommends deriving the reference value from the 75th percentile of the distribution of median dose values obtained from representative healthcare facilities; median values are preferred to mean values for facility comparisons because a small number of unusually high or low exposures can substantially influence a mean [1].

A DRL is not a regulatory dose limit and should not be used to judge whether an individual patient's exposure is acceptable. Similarly, it is not a target dose that must be achieved for every patient. Patient size, clinical indication, positioning, equipment, and other circumstances can justify exposures above or below a DRL. Persistent dose values above an appropriate DRL should instead prompt

investigation of equipment, exposure protocols, patient population, and image-quality requirements [1].

International guidance provides the conceptual and technical basis for interpreting DRLs [1, 5, 20, 21]. Historical European compilations also document reference-level practice [22], but the relevant survey date, population, projection and dose quantity must be checked before a benchmark is transferred to a modern department. This review therefore prioritises traceable study-specific values and currently published national guidance over a universal numerical threshold.

The transition from film-screen radiography to computed radiography (CR) and digital radiography (DR) has improved workflow and image processing but has introduced additional challenges in exposure management. Digital systems can produce diagnostically acceptable images over a relatively broad range of detector exposures, reducing the visual cues that previously indicated over- or underexposure. Consequently, exposure indicators and dose-monitoring systems have become important components of digital-radiography optimisation [2, 3].

Patient-dose distributions in chest radiography differ between countries and healthcare facilities, reflecting detector technology, generator characteristics, tube voltage, current-time product, source-to-image distance, patient body habitus, positioning, filtration, collimation, automatic exposure control, grid use, and image-processing algorithms. International comparisons must therefore be interpreted within the methodological context of each survey.

This review focuses on routine adult PA chest radiography and aims to distinguish potentially correctable practice variation from

differences caused by patient selection, detector technology and survey methodology. Its contribution is a focused comparative interpretation, rather than a new DRL or an exhaustive catalogue: it separates surface-dose/kerma from kerma-area-product evidence, identifies the conditions required for valid comparisons, and translates the findings into a practical investigation pathway for departments developing local dose audits. Unlike the broad national-DRL scoping review [9], the synthesis centres on one projection and its implementation; it complements the clinical-indication survey [8] and the review of radiographer awareness [19] by connecting methodological comparability with equipment, protocol and image-quality assessment. No claim is made that these principles or this topic have not previously been reviewed.

2. Review methodology

2.1 Design, sources and search date

This is a focused narrative review with a documented supplementary evidence-verification search undertaken on 6 October 2026. The original manuscript described source scanning and citation following but did not retain a reproducible database-search record; the supplementary search is therefore reported separately and is not presented as a reconstruction of the original retrieval. Recent empirical studies and reviews published from 1 January 2020 to 6 October 2026 were prioritised. Earlier ICRP, IAEA, European Commission and AAPM publications were retained for established DRL, dosimetry and image-quality principles.

Web search was used to locate records hosted by PubMed and PubMed Central (PMC), original publisher or institutional pages, and official ICRP, IAEA, European Commission and UK Health Security Agency resources. These are the information sources consulted; this was not a direct exhaustive search of the PubMed database interface. Scopus, Web of Science, Embase and CINAHL were not directly searched. Exact-title and author searches verified the studies already cited, while broader topic searches checked for relevant contextual evidence. A query-and-source audit accompanies the revision.

2.2 Search terms and eligibility

The searches combined terms for adult chest radiography, PA/posteroanterior projection, diagnostic reference levels, patient dose, patient size, computed/digital radiography and image quality. Executed topic queries included "site.pubmed.ncbi.nlm.nih.gov adult chest radiography diagnostic reference levels patient size image quality 2020 2026" and "site.pubmed.ncbi.nlm.nih.gov "adult" "chest" "diagnostic reference levels" "image quality" "2020"", together with exact-title/author searches and official-source searches. Search-result dates were checked against the publication record where available; 2026 does not imply coverage beyond the search date.

Eligible numerical evidence comprised adult routine PA chest patient-dose surveys, clearly labelled PA chest equipment/protocol surveys, and official adult PA chest reference values with an identifiable quantity and unit. Mixed-projection reports were used only when PA data could be separated, or were explicitly labelled as contextual chest evidence. Guidelines and reviews informed

interpretation rather than being counted as new primary dose surveys. Paediatric-only, CT, fluoroscopy, interventional, AP/mobile-only and lateral-only numerical evidence was excluded from the PA comparison. Non-English records were usable only when an accessible English abstract or translation permitted verification. Duplicate web records were reconciled by title and DOI/PMID.

2.3 Selection, extraction and synthesis

Retrieved titles and abstracts were checked for relevance, followed by accessible full text, original tables or official reports where available. When only an abstract or bibliographic record was accessible, extraction was limited to explicitly reported information; missing details were marked as not established from the accessible source. The numerical evidence table retains six selected empirical studies and one official UK reference source. It is a purposive comparative sample, not all eligible publications. No complete search-result denominator, PRISMA flow counts or independent duplicate screening is claimed.

The extracted fields were setting and sample, projection, patient-size restriction, CR/DR or equipment context, dose quantity, original and converted units, measurement method, reference-level/statistical basis, image-quality reporting and comparability limitations. Narrative synthesis grouped evidence by dosimetric quantity and explored methodological and clinical explanations of variation. Unit conversion was confined to the same physical quantity: $1 \text{ Gy}\cdot\text{cm}^2 = 1000 \text{ mGy}\cdot\text{cm}^2$ and $1 \text{ dGy}\cdot\text{cm}^2 = 100 \text{ mGy}\cdot\text{cm}^2$. No conversion between PKA and surface-dose/kerma quantities, pooled DRL, meta-analysis or causal estimate was attempted. A descriptive appraisal of reporting and applicability replaced formal risk-of-bias scoring; search incompleteness, access restrictions and selection bias remain limitations.

3. Diagnostic reference levels in medical imaging

The concept of a DRL was introduced to support optimisation of radiation protection in medical imaging, and ICRP Publication 135 provides the current international recommendations on definition, establishment, application, and updating of DRLs [1]. A DRL should be associated with a clearly defined examination, projection or clinical task, patient population, and DRL quantity; for projection radiography, the recommended quantities and symbols are entrance-surface air kerma ($K_{a,e}$), incident air kerma ($K_{a,i}$), and air kerma-area product (PKA) [1, 5]. For national DRLs, the 75th percentile of the distribution of representative facility median values is recommended [1].

An important distinction exists between a DRL value and an individual patient exposure. A patient whose exposure exceeds a DRL has not necessarily received an inappropriate exposure; persistent or systematic values above a relevant DRL indicate that the imaging process should be investigated to determine whether optimisation is appropriate [1]. DRLs are most useful when combined with image-quality assessment: reducing radiation exposure without maintaining sufficient diagnostic information may compromise the clinical purpose of the examination. DRL values should also be periodically reviewed, because changes in equipment, detector

technology, image-processing software, exposure protocols, or clinical practice can alter dose distributions [1, 4].

Reference values must be interpreted within their source context [1, 20–22]. A historical guidance level, a contemporary national DRL and a local patient-dose percentile are not interchangeable. Values below a reference do not by themselves establish adequate practice, because image quality must remain sufficient for the clinical purpose; values above it require investigation of representative group results rather than an automatic judgement about an individual exposure.

4. Patient-dose quantities in chest radiography

Several dosimetric quantities are used to characterise radiation exposure in projection radiography. Following ICRP Publication 135 and IAEA Technical Reports Series No. 457, the quantities and symbols recommended for DRLs in radiography are entrance-surface air kerma ($K_{a,e}$), incident air kerma ($K_{a,i}$), and air kerma-area product (PKA, also termed DAP) [1, 5]. The precise definition and measurement geometry should always be specified in a dose survey, because the numerical values are not interchangeable.

4.1 Entrance-Surface Air Kerma and Entrance-Surface Dose

Incident air kerma ($K_{a,i}$) characterises the radiation incident on the patient entrance surface excluding backscatter, whereas entrance-surface air kerma ($K_{a,e}$) includes the contribution of backscatter according to the adopted dosimetric definition. Entrance-surface dose (ESD) is commonly used in the literature as the corresponding absorbed-dose quantity. Consequently, $K_{a,i}$, $K_{a,e}$, and ESD should not be treated as interchangeable unless the measurement methodology and backscatter convention are clearly defined [5].

$K_{a,e}/K_{a,i}$ can be determined using a calibrated ionisation chamber under defined conditions or estimated from calibrated X-ray tube output and recorded exposure parameters; the selected method should be applied consistently across the patient sample and participating facilities [5]. Backscatter factors are relevant when converting incident air kerma to entrance-surface dose, and established Monte Carlo calculations can be used for this purpose [6].

4.2 Dose-Area Product (Kerma-Area Product)

The air kerma-area product (PKA or DAP) represents the product of air kerma and the corresponding X-ray beam area and may be measured using a calibrated DAP meter integrated into the radiographic system. PKA reflects both radiation output and irradiated field size and is therefore particularly useful for automated quality-assurance and large-scale dose-monitoring programmes [1, 5]. PKA and $K_{a,e}$ are different dosimetric quantities and should not be compared numerically without an appropriate methodology; a value in mGy cannot be directly compared with a value in Gy·cm². Earlier multicentre work has demonstrated the usefulness of DAP distributions for proposing preliminary DRLs [7].

4.3 Exposure Indicators

Digital radiography systems provide exposure indicators intended to give information about radiation exposure at the detector. Exposure

indicators should not be interpreted as direct measurements of patient dose; their meaning depends on detector technology, calibration, manufacturer conventions, and the relationship between detector exposure and the selected technique. The AAPM Imaging Physics Committee Task Group 232 report describes current practices regarding exposure indicators and deviation indices and provides recommendations for their use in monitoring technique and supporting optimisation [3]. Exposure indicators can therefore complement, but should not replace, patient-dose monitoring with $K_{a,e}$ or PKA.

5. Comparative evidence and methodological variation

Table 1 organises selected source data by quantity and explicitly records limits to comparability. In Sudan, the proposed PA chest value was 0.60 mGy ESAK across 29 hospitals; the abstract describes third quartiles of mean ESAK distributions, which differs from the facility-median approach recommended for national DRLs [10]. The South African study included 60 adults weighing 60–80 kg in three rooms and reported 0.30 mGy for CR and 0.20 mGy for DR using output-based ESAK estimation [11]. This within-site observation is informative, but it is not a controlled estimate of the detector effect. The Korean 2022 equipment survey explicitly lists adult chest PA ESD of 0.68 mGy and DAP of 769.23 mGy·cm² [12]. The latter is a PA-specific entry in its Table 2, not an unspecified aggregate chest-examination statistic. Its equipment/protocol-survey design must still be distinguished from dose distributions collected during routine patient examinations. The Algarve report provides a chest ESD reference of 0.44 ± 0.01 mGy from 41,320 radiographs and uses the third quartile of the total ESD distribution, with BMI-stratified analysis [13]. The accessible abstract does not establish every projection and detector detail; it is therefore retained as contextual chest evidence rather than treated as an unqualified PA-only comparison.

Dubai reported a PA chest local value of 0.51 dGy·cm² for adults weighing 60–80 kg [14], equivalent to 51 mGy·cm². The UK 2025 national table lists 0.077 Gy·cm² per PA radiograph, equivalent to 77 mGy·cm² [15]. These unit conversions are valid, but population and derivation differences preclude an inference that one service is better optimised. The Kazakhstan pilot included 60 adults across three systems and documented significant ESAK and incident-kerma differences, with higher doses on the older units [16]; numerical system-specific DRLs were not extracted from the accessible abstract.

The surface-dose/kerma examples span 0.20–0.68 mGy, but ESD and ESAK are kept under their reported labels. The PKA examples span 51–769.23 mGy·cm². Neither range is a pooled DRL or a recommended target. The broader national scoping review [9] and clinical-indication survey [8] provide context for the reporting and practice differences explored below.

Table 1. Selected adult chest reference data, methodological context and limits to comparison.

Source / value	Sample / projection	Patient size	Technology / dosimetry	Statistical basis	Image-quality evidence	Comparability limit
Sudan [10], 2020 ESAK 0.60 mGy	29 hospital s; adult PA	Adult sample; size restriction not established from abstract	Tube-output estimate using exposure factors; detector mix not established here	Third quartile of mean ESAK distributions, as described in abstract	Not established from accessible abstract	National proposal ; not explicitly a percentile of facility medians
South Africa [11], 2021 ESAK: CR 0.30; DR 0.20 mGy	60 adults; 3 rooms; PA values separated from LAT	60–80 kg; ≥18 years	2 CR rooms, 1 DR/FPD room; indirect output-based estimate	Reported local DRLs; room-specific results	Equipment QC described; clinical equivalence cannot be inferred from dose alone	Small single-site comparison; detector effect confounded with room/protocol
South Korea [12], 2023 ESD 0.68 mGy; PKA 769.23 mGy·cm ²	2022 survey; 382 general-radiography units; adult PA entry in Table 2	Adult protocol survey ; not a matched patient cohort	Inspection-agency equipment and exposure-protocol data	National reference values from equipment survey	Diagnostic-image assessment not established here	PA-specific DAP; sampling unit differs from clinical patient surveys
Algarve [13], 2024 Chest ESD 0.44 ± 0.01 mGy	41,320 adult chest radiographs; 7 centres	Standard patient and BMI intervals	Calculated ESD; detector/projection detail not established from abstract	Third quartile of total ESD distribution	Not established from accessible abstract	Contextual chest evidence ; PA-only scope requires full-text confirmation
Dubai [14], 2025 PA PKA 0.51 dGy·cm ² = 51 mGy·cm ²	Retrospective multicentre data; PA subgroup	60–80 kg subgroup	Projection- and weight-based DAP reporting	Reported projection-specific local DRL	Review does not infer task-specific image-quality equivalence	Size restriction and local derivation differ from national data
UK [15], 2025 PA PKA 0.077 Gy·cm ² = 77 mGy·cm ²	Official adult PA reference; per radiograph	Adult reference; not an individual dose target	DAP; general-radiography national table	Adopted national DRL	Official reference table is not a comparative image-quality study	Use projection-level value; do not substitute complete examination DAP

Source / value	Sample / projection	Patient size	Technology / dosimetry	Statistical basis	Image-quality evidence	Comparability limit
Kazakhstan [16], 2026 System-specific values not extracted	60 adults; 3 centres; 20/system; PA	70 ± 20 kg; ≥18 years	Systems dated 2007, 2009, 2024; calibrated multimeter; ESAK and incident kerma	Preliminary local DRLs; differences p < 0.05	Equipment QC examined; diagnostic equivalence not established from abstract	Pilot; age confounded with system and protocol; no numerical value invented

ESAK and ESD retain the source labels and are not assumed equivalent. PKA/DAP values are converted only within the same quantity. “Not established” indicates a limitation of the accessible source, not proof that the original study omitted the item. The table contains six empirical studies plus one official reference source; it is not exhaustive.

6. Critical discussion: interpreting dose differences

6.1 Patient size and sampling

Differences between countries should first be treated as differences between sampled populations and survey designs, rather than evidence of national practice quality. A 60–80 kg restriction in the South African and Dubai sources [11, 14] differs from the wider 70 ± 20 kg range in Kazakhstan [16]. Restriction improves standard-patient comparability but reduces applicability to smaller or larger adults. Weight and BMI also do not uniquely describe chest thickness or attenuation. The BMI dependence reported in Algarve [13] supports recording size and, when numbers permit, presenting stratified results. A service with more large patients could have a higher unadjusted distribution despite appropriate techniques; conversely, preferential selection of smaller patients could obscure excessive exposure. These are plausible interpretive mechanisms, not effects estimated by this review.

6.2 Equipment age, maintenance and detector technology

The Kazakhstan pilot associates older systems with higher doses [16], but age co-varies with generator performance, detector characteristics, filtration, maintenance and protocol settings. Its three-system design does not isolate chronological age. Importantly, the larger clinical-indication survey found no significant age-related differences for most procedures [8]; those general-radiography findings are contextual rather than a PA-chest-only effect estimate. Together, the studies argue for testing equipment performance and protocols rather than assuming that replacement alone will correct a high dose. The South African CR and DR values differ by approximately one third [11], but the three rooms were not interchangeable experimental conditions. Detector efficiency, exposure targets, processing, AEC settings and operator practice may contribute. CR and DR should therefore be separated in an audit, while claims of a universal DR dose advantage should be avoided. Digital post-processing may conceal excessive exposure visually; detector exposure indices and deviation indices help monitor practice but cannot substitute for patient-dose quantities [2, 3].

6.3 Exposure technique and institutional practice

Tube voltage, mAs, filtration, grid use, source-to-image distance and collimation must be evaluated as a technique, not as isolated settings [2–4, 17]. A higher kVp may permit lower mAs, but its final benefit depends on penetration, detector response and the diagnostic task. Changing one parameter without reassessing the image can shift noise, contrast or AEC response. Where AEC is used, chamber selection, positioning and detector exposure targets deserve review; manual protocols require consistent adaptation to body habitus. Excessive field size raises PKA through irradiated area as well as contributing scatter. Thus, differences in PKA may partly reflect collimation even when surface kerma is similar. Practical investigation should retrieve acquisition parameters alongside dose, rather than infer the cause from the dose value alone.

6.4 Measurement and statistical differences

A numerical comparison is defensible only after checking projection, quantity, units and measurement convention. Incident kerma excludes backscatter; entrance-surface air kerma includes it under the stated convention, while ESD is an absorbed-dose label [5, 6]. Output-based estimates depend on calibration, geometry and the factors used to account for backscatter. Meter-derived PKA additionally requires verified calibration and a clear field/projection definition. Displayed versus independently measured data and their uncertainties should be recorded. Harmonising mGy·cm² and Gy·cm² corrects scale, not differences in clinical or statistical meaning.

The Sudan abstract uses distributions of mean ESAK values [10], whereas Algarve uses the pooled patient-dose distribution [13]. Neither should silently be described as a 75th percentile of facility medians. Large centres can dominate a pooled patient dataset, while a percentile of facility summaries weights facilities differently. The Korean protocol/equipment survey [12] also represents a different sampling unit from a patient survey. National, regional and local labels therefore require examination of how the percentile was actually constructed; the label alone is insufficient evidence of comparability.

6.5 Image quality and the interpretation of low dose

A low reference value is not proof of successful optimisation. Image adequacy must be evaluated for the clinical task [4, 18], and technical QC must be distinguished from direct assessment of diagnostic images. A calibrated, well-performing unit can still use an unsuitable clinical protocol. Clinical review should document anatomical visibility, penetration, positioning, motion, noise and artefacts using defined criteria; objective phantom measurements can complement it. Exposure indices, reader scores and repeat/reject data provide different information and should not be treated as equivalent measures of diagnostic performance. When image-quality details cannot be verified from the accessible study, the review cannot conclude that a lower-dose setting preserved diagnostic effectiveness.

6.6 Practical contribution: a staged comparability and investigation pathway

Before comparing a local median with an external reference, the department should confirm five conditions: the same PA examination and clinical setting; a comparable patient-size group; a known detector/equipment context; the same calibrated dose quantity and projection-level reporting; and a compatible statistical basis with concurrent image-quality assessment. If these conditions are not met, the external value is contextual evidence rather than a direct performance threshold. Once comparability is established, investigate measurement validity and patient mix, then equipment QC and exposure settings, and finally diagnostic images and repeats. Select corrective action with the radiographer, radiologist and medical physicist, and re-audit representative groups after the intervention. This pathway synthesises established guidance [1, 4, 5, 20] for PA chest practice; it is not a newly validated clinical algorithm.

7. Practical approach to establishing a local PA chest DRL

Where a national DRL is unavailable, or where local equipment and clinical practice differ substantially from national reference data, a local DRL provides a useful baseline for optimisation. Figure 1 summarises the workflow; a practical local programme includes the following steps:

Define the examination precisely as routine adult PA chest radiography and specify the clinical setting.

Define the patient population and, where possible, record patient weight, BMI, or another suitable measure of body habitus.

Identify the imaging technology, including CR or DR, detector type, generator, and automatic exposure-control configuration.

Select and clearly define the DRL quantity and measurement method (K_{a,e}/ESD or PKA), with calibrated instrumentation or a validated output-based method [5]. Collect a representative sample of examinations using clearly defined inclusion criteria; ICRP Publication 135 suggests a minimum of about 10 patients per facility per mode for simple examinations such as chest radiography, with larger samples where variability is high [1]. Record relevant exposure parameters, including kVp, mAs, source-to-image distance, and field size where available. Evaluate image quality using defined clinical or technical criteria [18]. Calculate facility-specific dose distributions and median values, and document the percentile method used. Compare local results with an appropriate national, regional, or international reference using the same or a clearly compatible methodology and quantity. Investigate persistent values above the relevant reference level and identify potentially correctable causes (equipment, protocol, positioning, collimation, processing). Implement optimisation measures and repeat the assessment periodically, and whenever equipment, detector technology, or software changes substantially [1, 4].

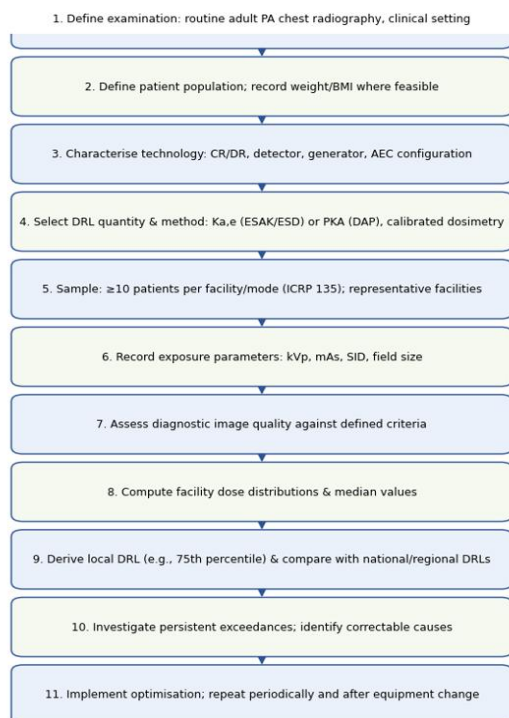


Figure 1. Practical workflow for establishing and maintaining a local diagnostic reference level for routine adult PA chest radiography (steps correspond to Section 7).

8. Role of radiographers and staff education

Radiographers are central to the practical implementation of optimisation because they influence exposure selection, positioning, collimation, patient-size adaptation, and image acquisition. A 2025 scoping review examining radiographers' awareness, understanding, and implementation of DRLs identified recurring themes related to knowledge, radiation protection, dose optimisation, training, institutional policies, and regulatory oversight [19]. Establishing a DRL alone is therefore insufficient: staff should understand that a DRL is neither a target dose nor a dose limit, and when an exposure above the reference level warrants investigation versus when patient or clinical circumstances provide a legitimate explanation. Education programmes that incorporate exposure indicators, patient-dose data, image-quality assessment, equipment performance, and periodic feedback support more consistent implementation of optimisation principles [3, 4, 19].

9. Current evidence gaps

The selected evidence has incomplete consistency in patient-size selection, projection reporting, dose definitions, detector separation, percentile derivation and direct clinical image-quality assessment. In this review, purposive retrieval, web-index coverage and restrictions on full-text access introduce additional selection and extraction limitations. No independent duplicate screening or formal risk-of-bias assessment was performed, and unavailable fields were not inferred. The table is not a comprehensive survey of countries, and causal attribution of differences or a universal updated DRL cannot be supported. These limitations restrict the conclusions to methodological interpretation and practical audit planning.

Future studies should use clearly defined examination protocols, representative adult populations, calibrated dosimetry, transparent percentile calculations, and concurrent image-quality evaluation. Where feasible, automated dose-management systems should be used to collect large samples and support longitudinal monitoring [4].

10. Implications for routine PA chest radiography

For routine adult PA chest radiography, the proposed checklist supports a department in deciding whether an external value is directly applicable or only contextual. Dose data should be reviewed with patient size, equipment performance, exposure parameters and image-quality findings. Group-level deviations warrant investigation; protocol changes should be followed by a fresh audit rather than assumed to achieve optimisation [1, 4, 20, 21]. A local baseline is particularly useful where national data are unavailable, but it should not be represented as a nationally representative reference.

11. Research priorities

Future research should focus on harmonising DRL methodologies and improving the clinical usefulness of patient-dose surveys. Important priorities include: national and multicentre DRL programmes for adult chest radiography; standardised reporting of $Ka,e/Ka,i$ and PKA; explicit separation of CR and DR technologies; patient-size-specific or size-adjusted reference levels; indication-specific chest-radiography DRLs [8]; simultaneous assessment of radiation dose and diagnostic image quality; automated dose monitoring and longitudinal trend analysis; evaluation of optimisation interventions before and after implementation; investigation of dose differences associated with equipment age and detector technology [16]; and improved education and institutional policies for DRL interpretation [19]. Multicentre datasets are particularly valuable because they provide more representative dose distributions and help distinguish genuine practice differences from population, equipment, or methodological artefacts.

12. Conclusion

For adult PA chest radiography, published reference values are useful only when interpreted with their examination, patient-size, technology, dosimetry and statistical context. The selected evidence shows substantial variation, but this narrative synthesis cannot determine how much is caused by national practice, detector performance, patient mix or measurement design. Its practical contribution is to make those comparability conditions explicit and link them to a staged investigation of dose and image quality. Departments should use representative group medians, a compatible reference, verified measurements and diagnostic-image assessment to guide optimisation. Neither a value below a DRL nor replacement of an older system alone proves adequate practice. Where national data are unavailable, a transparent local audit can establish a baseline, identify modifiable causes and evaluate improvement after protocol or equipment changes. The objective remains clinically adequate imaging with appropriately optimised exposure, not convergence on a universal dose target.

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Conflict of interest

The authors declare that they have no conflict of interest.

Ethical statement

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References

1. Vañó E, Miller DL, Martin CJ, Rehani MM, Kang K, Rosenstein M, Ortiz-López P, Mattsson S, Padovani R, Rogers A. Diagnostic reference levels in medical imaging. ICRP Publication 135. Ann ICRP. 2017;46(1):1–144.
2. International Commission on Radiological Protection. Managing patient dose in digital radiology. ICRP Publication 93. Ann ICRP. 2004;34(1):1–75.
3. Dave JK, Jones AK, Fisher R, Hulme K, Rill L, Zamora D, Woodward A, Brady S, MacDougall RD, Goldman L, Lang S, Peck D, Apgar B, Shepard SJ, Uzenoff R, Willis C. Current state of practice regarding digital radiography exposure indicators and deviation indices: Report of AAPM Imaging Physics Committee Task Group 232. Med Phys. 2018;45(11):e1146–e1160. doi:10.1002/mp.13212.
4. Martin CJ, Applegate K, Hernandez-Giron I, Hussein D, Kortensniemi M, Del Rosario Perez M, Sutton DG, Vassileva J. Optimisation of radiological protection in digital radiology techniques for medical imaging. ICRP Publication 154. Ann ICRP. 2023;52(3):11–145.
5. International Atomic Energy Agency. Dosimetry in diagnostic radiology: an international code of practice. Technical Reports Series No. 457. Vienna: IAEA; 2007.
6. Petoussi-Henss N, Zankl M, Drexler G, Panzer W, Regulla D. Calculation of backscatter factors for diagnostic radiology using Monte Carlo methods. Phys Med Biol. 1998;43(8):2237–2250.
7. Jibiri NN, Olowookere CJ. Evaluation of dose-area product of common radiographic examinations towards establishing a preliminary diagnostic reference levels (PDRLs) in Southwestern Nigeria. J Appl Clin Med Phys. 2016;17(6):392–404. doi:10.1120/jacmp.v17i6.6011.
8. Schegerer AA, Stamm G, Aberle C, Ammon J, Bazrafshan B, Borowski M, Eßeling R, Madsack B, Menz R, Müller C, Oberhofer N, Renger B, Singer J, Verius M, Walz M, Jungnickel K. International survey on diagnostic reference levels based on clinical indications in plain radiography. Eur Radiol. 2025;35(6):3336–3346. doi:10.1007/s00330-024-11224-2.
9. Abbeyquaye D, Inkoom S, Dery TB, Issahaku S, Ohene-Botwe B. National diagnostic reference levels in general radiography: a scoping review. J Med Phys. 2025;50(2):207–216.
10. Ahmed NA, Basheir EH, Farah AB, Mohammedzein TS, Suliman II. Proposed national diagnostic reference levels for standard radiographic X-ray procedures in Sudan. Radiat Prot Dosimetry. 2020;190(4):419–426. doi:10.1093/rpd/ncaa114.
11. Junda M, Muller H, Friedrich-Nel H. Local diagnostic reference levels for routine chest X-ray examinations at a public sector hospital in central South Africa. Health SA Gesondheid. 2021;26:a1622. doi:10.4102/hsag.v26i0.1622.
12. Yoon YS, Park HM, Won JH, Song SK, Gil JW, Lee BY. Korean diagnostic reference level for general radiography and mammography in 2022. Public Health Wkly Rep. 2023;16(31):1082–1100. doi:10.56786/PHWR.2023.16.31.2.
13. Arriaga A, Gonçalves C, Teles P, Santos J, Simãozinho P, Sousa P. Establishment of local diagnostic reference levels for abdomen and chest radiographies in the region of Algarve, Portugal. Eur J Radiol. 2024;170:111248. doi:10.1016/j.ejrad.2023.111248.
14. Dalah EZ, Zarooni MMA, Binismail FY, Beevi HA, Siraj M, Pottybindu S. Typical and local diagnostic reference levels for chest and abdomen radiography examinations in Dubai health sector. J Imaging. 2025;11(1):21. doi:10.3390/jimaging11010021.
15. UK Health Security Agency. National diagnostic reference levels (NDRLs) from 11 December 2025. London: UKHSA; 2025. Available from: <https://www.gov.uk/government/publications/diagnostic-radiology-national-diagnostic-reference-levels-ndrls/ndrl> (accessed 6 October 2026).
16. Aumalikova M, Nurseitova B, Kashkinbayev Y, Bakhtin M, Aisauyt M, Ibrayeva D, Kusherbayev N, Ilbekova K. Local diagnostic reference levels for routine chest X-ray examinations: first pilot study in Kazakhstan. Z Med Phys. 2026. doi:10.1016/j.zemedi.2026.02.003.
17. Launders JH, Cowen AR, Bury RF, Hawkrigide P. Towards image quality, beam energy and effective dose optimisation in digital thoracic radiography. Eur Radiol. 2001;11(5):870–875.
18. European Commission. European guidelines on quality criteria for diagnostic radiographic images. Luxembourg: European Commission; 1996. EUR 16260 EN.
19. Ncwane V, Gumede L, Van Wyk B. Radiographers' awareness, understanding, and implementation of diagnostic reference levels in medical imaging: a scoping review. J Med Imaging Radiat Sci. 2025;56(6):102101. doi:10.1016/j.jmir.2025.102101.
20. International Atomic Energy Agency. Radiation protection and safety in medical uses of ionizing radiation. IAEA Safety Standards Series No. SSG-46. Vienna: IAEA; 2018.
21. International Atomic Energy Agency. Radiation protection and safety of radiation sources: international basic safety standards. IAEA Safety Standards Series No. GSR Part 3. Vienna: IAEA; 2014.
22. European Commission. Diagnostic reference levels in thirty-six European countries. Radiation Protection No. 180, Part 2. Luxembourg: Publications Office of the European Union; 2014.
23. Mettler FA Jr, Huda W, Yoshizumi TT, Mahesh M. Effective doses in radiology and diagnostic nuclear medicine: a catalog. Radiology. 2008;248(1):254–263.