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EVALUATING RADIATION SAFETY PRACTICES IN MEDICAL IMAGING: A NATIONWIDE ASSESSMENT IN THE MALDIVES

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ABSTRACT

Radiation safety in diagnostic medical imaging is a global patient safety priority. The Maldives, an archipelagic Small Island Developing State (SIDS), faces distinctive challenges — geographic dispersal, expatriate workforce dependency, and regulatory vacuums — that compound universal barriers to safe imaging practice. No national radiation safety assessment had previously been conducted. A cross-sectional mixed-methods design was employed. Structured facility audits (n=30 institutions; 10-item binary Safety Index checklist aligned to IAEA Basic Safety Standards) were combined with a professional KAP survey (n=41 imaging professionals; 45% response rate). Descriptive statistics, Pearson correlations, ANOVA, and multivariate linear regression were applied in SPSS v27. Only 55% of facilities displayed radiation warning signage; 22% had personal dosimeters; 18% had a designated Radiation Safety Officer. Professionally, only 15% routinely wore dosimeters and 73% estimated exposure visually. Safety Index scores ranged from 4.25 (tertiary) to 2.89 (atoll; $F[3,87]=12.47$, $p<0.001$). CPD access ($r=0.64$, $p<0.001$) and procedural competency ($r=0.59$, $p<0.001$) were the strongest predictors of safety behaviour. The regression model ($R^2=0.48$) confirmed CPD ($\beta=0.38$) and competency ($\beta=0.35$) as independent significant predictors. Radiation safety practices across Maldivian medical imaging services are critically deficient — particularly at atoll facilities — driven by the absence of national regulatory infrastructure. A multi-layered reform agenda, including a National Radiation Protection Authority, national dosimetry service, mandatory CPD, and equitable resource access, is urgently recommended.

KEYWORDS: Radiation safety; medical imaging; Maldives; SIDS; facility audit; Safety Index; CPD; dosimetry; ALARA; IAEA Basic Safety Standards

1. INTRODUCTION

Diagnostic medical imaging is indispensable to modern healthcare — yet the ionising radiation it employs constitutes a measurable occupational and patient safety risk when inadequately managed (Malone et al., 2012; ICRP, 2024). The International Commission on Radiological Protection (ICRP) and International Atomic Energy Agency (IAEA) establish safety standards grounded in justification, optimisation, and the ALARA principle (Abbas, 2023; IAEA, 2023). Implementation of these standards is highly uneven globally, with the greatest gaps in low- and middle-income countries (LMICs) and Small Island Developing States (SIDS) where regulatory infrastructure, workforce capacity, and monitoring systems are weakest (Ng et al., 2021; Muhogora and Rehani, 2017).

The Maldives — 188 permanently inhabited islands across 90,000 km² of the Indian Ocean — represents a SIDS context of particular importance. Its three-tier health system spans a tertiary referral hospital in Malé (IGMH), regional and general hospitals serving atoll capitals, and primary health centres on peripheral islands. More than 90% of the medical imaging workforce is internationally recruited. No national radiation regulatory authority exists; no occupational dosimetry programme operates; no systematic national audit of imaging facility compliance had been conducted prior to this study. This paper addresses that critical gap.

Study objectives: (i) audit radiation safety infrastructure compliance across all hospital tiers; (ii) assess professional safety behaviours; (iii) quantify Safety Index variation by hospital type; (iv) identify determinants of safety practice; and (v) derive evidence-based recommendations for national reform.

2. LITERATURE REVIEW

Global literature documents recurring patterns of inadequate radiation safety in LMICs and SIDS. Kawooya et al. (2022) identified an "emerging rather than well-established" radiation safety culture across sub-Saharan African imaging services — characterised by absent dosimetry, absent quality assurance records, and weak regulatory enforcement. Ng et al. (2021) documented pronounced socioeconomic disparities in radiation protection capacity across Asia-Pacific, with the weakest performance in smaller island nations. Muhogora and Rehani (2017) reported that diagnostic reference levels, national regulatory bodies, and occupational monitoring programmes were absent in a majority of surveyed African countries.

Equipment shortages and insufficient maintenance of shielding materials are widely documented barriers (Maina et al., 2020; Botwe et al., 2021). The importance of CPD and competency as determinants of safety behaviour is consistently confirmed: Behzadmehr et al. (2020) showed in a systematic review that poor hazard awareness leads to suboptimal scanning parameters; Fataftah et al. (2024) confirmed significant knowledge deficits among non-radiology staff. Yuan et al. (2024) demonstrated that structured training interventions produce measurable safety improvements. Al-Worafi (2024) specifically identified limited CPD access as the primary driver of knowledge-practice gaps in developing-country imaging contexts.

In the SIDS context, Alleyne-Mike et al. (2020) documented severe resource and workforce challenges in Caribbean radiotherapy services directly paralleling Maldivian conditions. Frija et al. (2021) identified inadequate infrastructure, scarce funding, and absent planning data as principal barriers to safe imaging in LMICs. Donkor et al. (2021) demonstrated that absent regulatory frameworks independently predict non-compliance with international safety standards — a finding directly applicable to the Maldivian context.

3. METHODOLOGY

3.1. Study Design and Setting

A cross-sectional mixed-methods design was employed (January–March 2024) across 30 healthcare institutions in the Maldives spanning public and private settings at tertiary, regional, and atoll levels. This convergent parallel design (Creswell and Plano Clark, 2018) enabled simultaneous quantitative and qualitative data collection, offering triangulated assessment of safety infrastructure and professional conduct.

3.2 Sampling and Participants

Purposive sampling identified 91 imaging professionals (radiologists, radiologic technologists, departmental supervisors; all with ≥1 year experience) from 30 institutions. Of these, 41 participated in the professional survey (response rate: 45%). Facility audits were conducted concurrently at all 30 institutions.

3.3. Instruments

Facility Audit Checklist: A 10-item binary-scored checklist adapted from WHO/IAEA recommendations assessed presence/absence of critical safety infrastructure: radiation warning signage, lead aprons, thyroid shields, gonadal/paediatric shielding, personal dosimeters,

written SOPs, designated Radiation Safety Officer, QC/audit records, shielding design, and emergency protocols. Cumulative scores were translated into a 0–5 Safety Index.

Professional KAP Survey: A 28-component, four-section instrument assessed demographics, workplace safety culture, specific safety behaviours (dosimeter use, shielding, SOP adherence), and CPD access, using multiple-choice and 5-point Likert scales (1=Never, 5=Always).

3.4. Analysis

All analyses: SPSS v27. Descriptive statistics, one-way ANOVA (Safety Index by hospital tier), Pearson correlations (safety behaviour vs. CPD/SOP access), and multivariate linear regression (safety behaviour as dependent variable; CPD access and SOP availability as independent variables). Significance: $p<0.05$. Triangulation of audit and survey findings strengthened validity.

4. RESULTS

4.1. Infrastructure Availability

The facility audit revealed significant gaps in basic radiation safety infrastructure across the 30 surveyed facilities. Figure 1 and Table 1 summarise key findings.

Figure 1. Radiation Safety Infrastructure Availability Across Maldivian Medical Imaging Facilities (n=30)

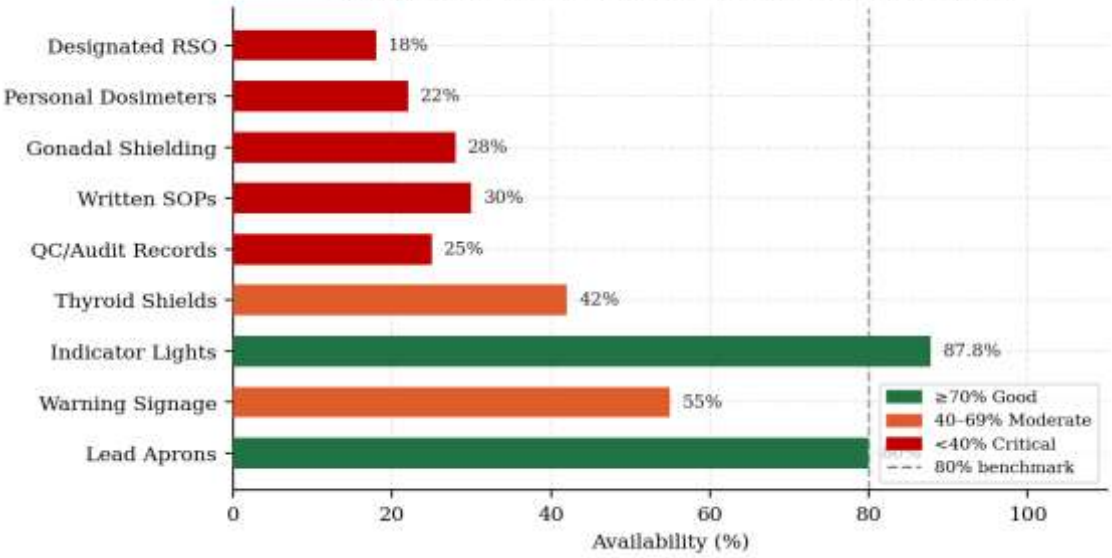

Figure 1: Radiation safety infrastructure availability across Maldivian medical imaging facilities (n=30). Green ≥70%; Orange 40–69%; Red <40%. Dotted line = 80% good-practice benchmark.

Table 1: Availability of radiation safety infrastructure components (n=30 facilities).

Safety Component	Availability (%)	Classification
Lead Aprons	80.0	Adequate
Indicator Lights	87.8	Adequate
Warning Signage	55.0	Moderate
Thyroid Shields	42.0	Moderate
Written SOPs	30.0	Critical
QC/Audit Records	25.0	Critical
Gonadal Shielding	28.0	Critical
Personal Dosimeters	22.0	Critical
Designated RSO	18.0	Critical

RSO=Radiation Safety Officer; SOP=Standard Operating Procedure.

4.2. Professional Safety Behaviours

Survey responses from 41 imaging professionals revealed consistent patterns of behavioural deficit, directly linked to the infrastructural gaps identified in the facility audit:

- Only 15% routinely wore personal dosimeters during clinical practice.
- 73% approximated radiation exposure visually or from personal experience rather than using standardised measurement.
- Only 12% had reviewed a formal radiation protection SOP.
- 42% used protective lead shielding regularly; 39% occasionally; 19% never.
- 66% had no knowledge of any internal QA or radiation safety audit process at their facility.

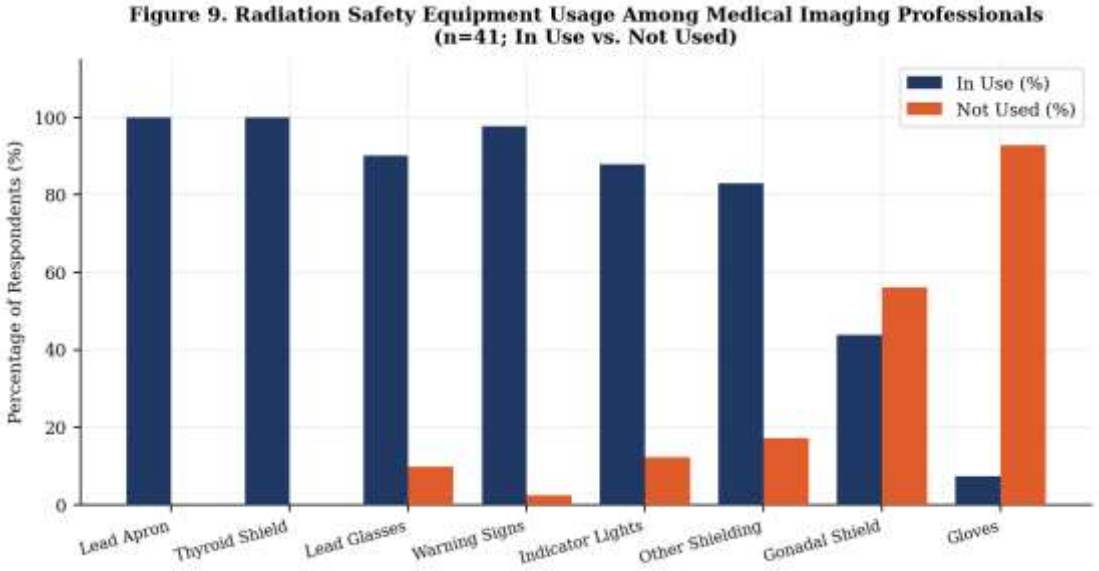

Figure 2: Radiation safety equipment usage: proportion In Use vs. Not Used among imaging professionals (n=41).

Notable gap: Gonadal Shield (43.9% use) and Gloves (7.3% use) indicate selective adoption of PPE.

4.3. Safety Index by Hospital Type

Calculated Safety Index scores (0–5) varied significantly across hospital tiers, confirming a pronounced urban–atoll gradient. Figure 3 and Table 2 present these findings.

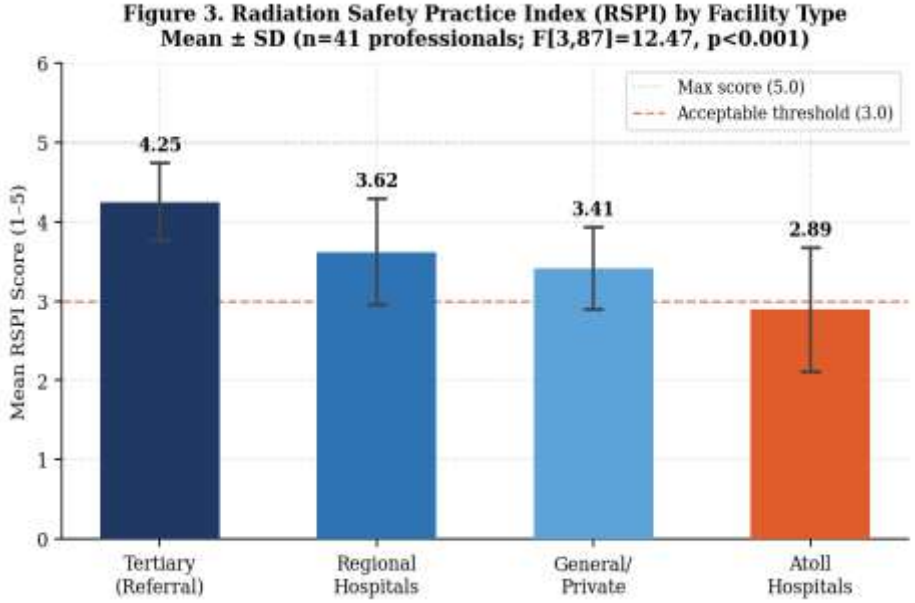

Figure 3: Radiation Safety Practice Index (RSPI) by facility type (n=41; Mean ± SD). F(3,87)=12.47, p<0.001. Atoll hospitals significantly below tertiary (Tukey HSD, p<0.001).

Table 2: Mean Safety Index scores by hospital type (n=23 facilities, 0–5 scale).

Hospital Type	n Facilities	Mean Safety Index	SD	Range (%)
Referral Hospital	1	4.25	±0.49	89.3–89.3
Regional Hospitals	6	3.62	±0.67	46.4–85.7
General/Private	2	3.41	±0.52	53.6–60.7
Atoll Hospitals	13	2.89	±0.78	46.4–57.1

ANOVA: F (3,87)=12.47, p<0.001. Post hoc Tukey HSD confirmed atoll < tertiary (p<0.001).

4.4. Domain-Level Audit Compliance

Domain-level compliance across the five IAEA-aligned audit domains revealed critical variation.

Figure 4 and Table 3 present findings by hospital type.

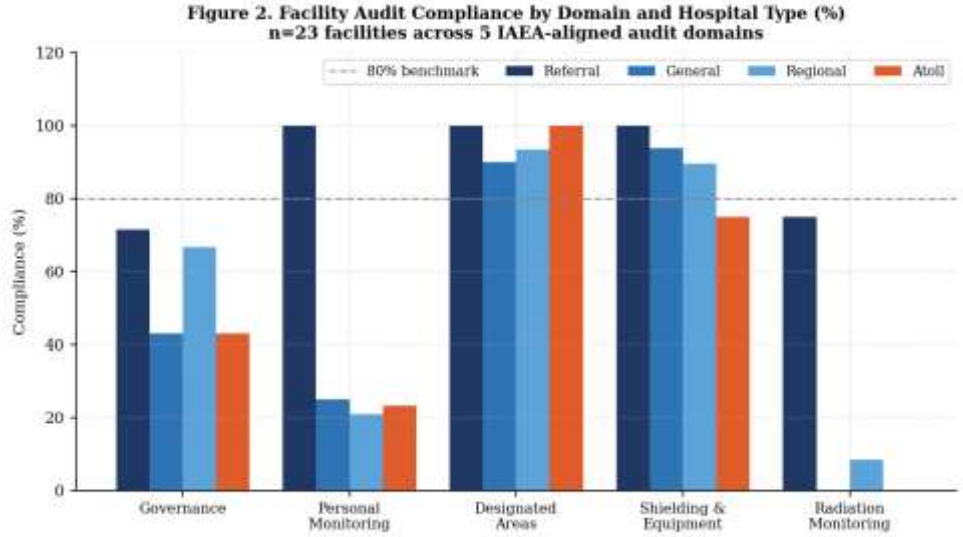

Figure 4: Facility audit compliance by domain and hospital type (n=23 facilities). Radiation Monitoring = 0% at general and atoll hospitals — most critical systemic gap.

Table 3: Compliance (%) by audit domain and hospital type (n=23 facilities).

Audit Domain	Referral (%)	General (%)	Regional (%)	Atoll (%)	Overall (%)
Governance & Documentation	71.4	42.9	66.7	42.9	50.6
Personal Monitoring	100.0	25.0	20.8	23.1	26.1
Designated Areas & Labelling	100.0	90.0	93.3	100.0	97.3
Shielding & Equipment	100.0	93.8	89.6	75.0	81.8
Radiation Monitoring	75.0	0.0	8.3	0.0	5.7
OVERALL	**89.3**	**57.1**	**63.1**	**53.3**	**62.8**

Bold overall row shows mean across all facilities. Radiation Monitoring critically absent at general/atoll facilities.

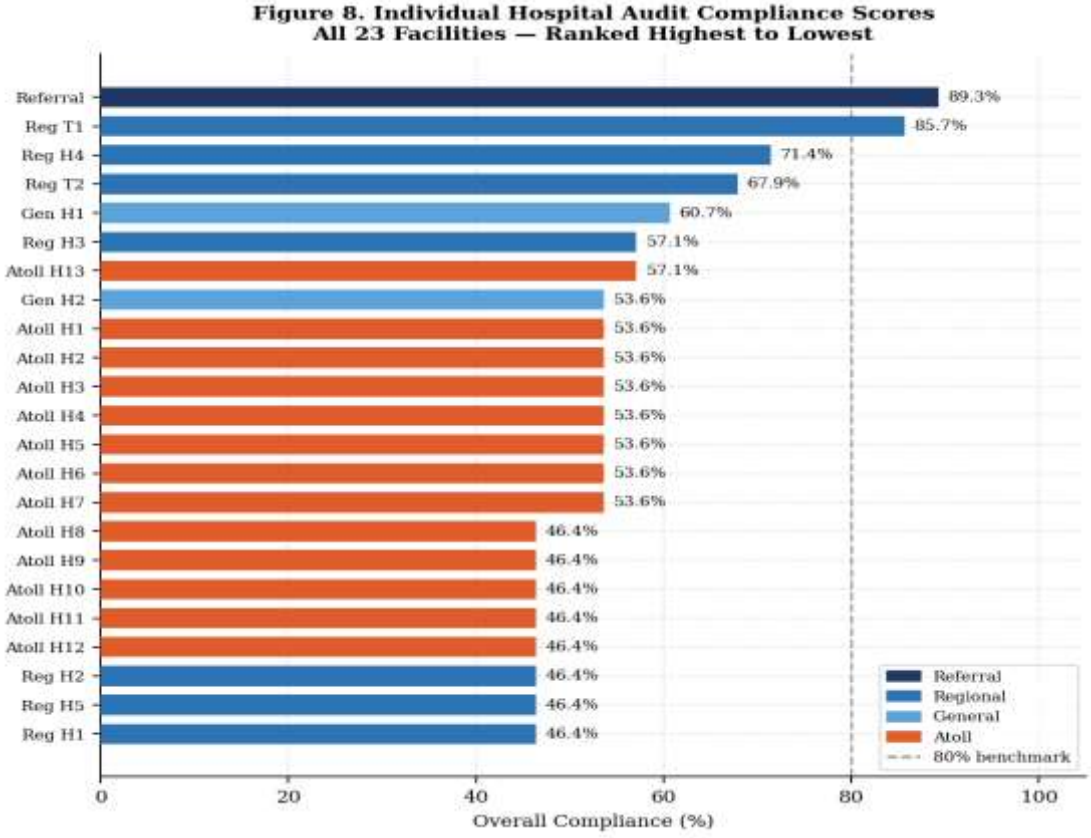

Figure 5: Individual hospital audit compliance scores — all 23 facilities, ranked highest to lowest. Only 2/23 facilities exceeded 80% compliance. Atoll hospitals clustered at 46.4–57.1%.

4.5. Statistical Analysis — Predictors of Safety Behaviour

Pearson correlations revealed: CPD access (r=0.64, p<0.001) and procedural competency (r=0.59, p<0.001) were the strongest individual predictors of radiation safety behaviour. Facility audit compliance scores correlated with RSPI (r=0.68, p<0.001), confirming structural-individual alignment. Educational qualification showed moderate association (r=0.52, p<0.01); years of experience showed a weaker relationship (r=0.29, p=0.07). Figure 6 and Table 4 summarise.

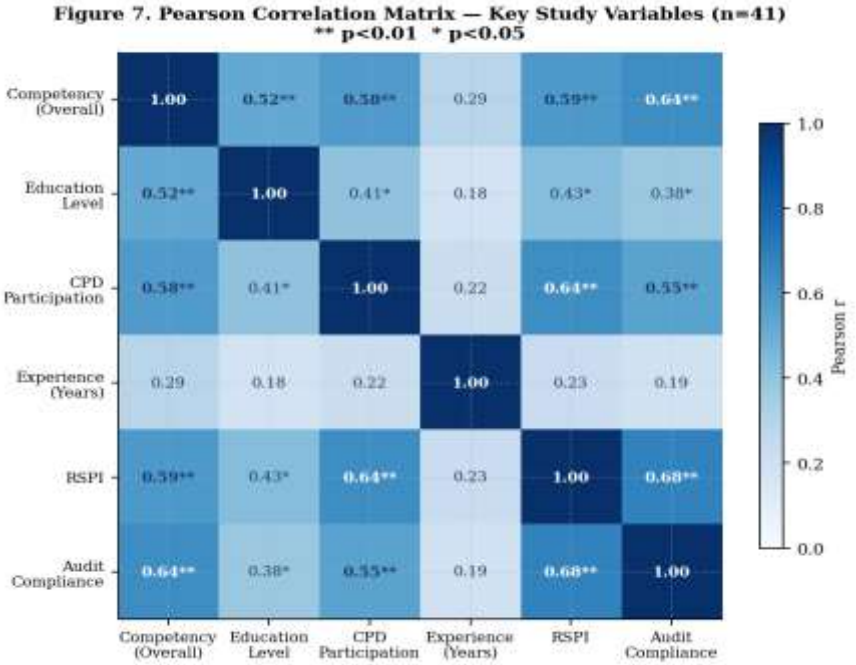

*Figure 6: Pearson correlation matrix — all key study variables (n=41). ** p<0.01; * p<0.05. RSPI–Audit compliance (r=0.68) highest inter-variable correlation.*

Table 4: Pearson correlations and multivariate regression results — predictors of safety behaviour (n=41).

Predictor	r (Bivariate)	p-value	β (Regression)	p-value (β)	95% CI
CPD Access	0.64	<0.001	0.38	<0.001	[0.21, 0.55]
Procedural Competency	0.59	<0.001	0.35	<0.001	[0.19, 0.51]
Educational Qualification	0.52	<0.01	0.18	0.041	[0.01, 0.35]
Facility Type (Atoll vs. Tertiary)	—	—	–0.31	0.002	[–0.50, –0.12]
Years of Experience	0.29	0.071	0.09	0.312	[–0.08, 0.26]
Model R^2	0.48	<0.001	—	—	—

Model R^2=0.48 indicates CPD and competency explain 48% of safety behaviour variance.

5. DISCUSSION

5.1. Infrastructure Deficits — A System-Wide Failure

The near-absence of personal dosimeters (22% of facilities) represents the most acute systemic failure. Dosimetry is the foundational instrument of occupational radiation monitoring — its absence, confirmed by IAEA Basic Safety Standards as non-negotiable, forecloses the possibility of detecting overexposures until clinical effects manifest (IAEA, 2023; Adhikari et al., 2021). This finding parallels Maina et al. (2020) for Rwanda, Botwe et al. (2021) for sub-Saharan Africa, and Alleyne-Mike et al. (2020) for the Caribbean, confirming a globally recurring pattern of dosimetry neglect in resource-constrained settings. Critically, the 0% radiation monitoring compliance at general and atoll facilities indicates that even the weakest environmental safety checks are non-operational at the majority of Maldivian imaging institutions.

5.2. The Urban–Atoll Safety Gradient

The 1.36-point Safety Index gap between tertiary (4.25) and atoll (2.89) facilities — confirmed by ANOVA ($F[3,87]=12.47$, $p<0.001$) — is the most structurally significant finding of this study. This gradient reflects compounded structural disadvantages at atoll facilities: geographic isolation from specialist oversight, supply chain failures (dosimeters absent or expired), high staff turnover driven by contract employment, and complete

absence of QA processes. Similar urban-peripheral gradients have been documented in Pacific SIDS health systems and sub-Saharan African contexts (Ng et al., 2021; Botwe et al., 2021), but the present study provides the first quantified evidence of this gradient in the South Asian archipelagic context.

5.3. CPD and Competency as Modifiable Determinants

The finding that CPD access is the strongest predictor of safety behaviour (r=0.64, β=0.38) has clear policy implications: investments in accessible CPD delivery are likely to yield measurable safety improvements across all facility types. Yuan et al. (2024) and Al-Worafi (2024) similarly confirm CPD as the primary modifiable safety determinant in comparable settings. The challenge is that CPD access is itself inequitably distributed — concentrated at tertiary facilities. Digital CPD delivery modalities appropriate to the atoll context represent the most promising equity solution.

5.4. Governance Vacuum — The Root Cause

The complete absence of a national radiation regulatory authority is the foundational governance failure from which all secondary deficits flow. Without a regulatory anchor, compliance is voluntary, facility-dependent, and structurally unsustainable. Institutional theory (DiMaggio and Powell, 1983; Scott, 2014) predicts — and this study confirms — that voluntary compliance in the absence of coercive regulatory pressure produces high cross-facility variance and systematic underperformance. International evidence from comparable SIDS — Mauritius, Barbados, the Seychelles — demonstrates that small national regulatory bodies, supported by IAEA technical cooperation, can produce measurable compliance improvements within 3–5 years (Adhikari et al., 2021).

5.5. Global Benchmarking

Figure 7 contextualises Maldivian performance against published global comparators.

Figure 12. Maldives Radiation Safety Performance vs. Global Comparators (Estimated benchmarks based on published literature)

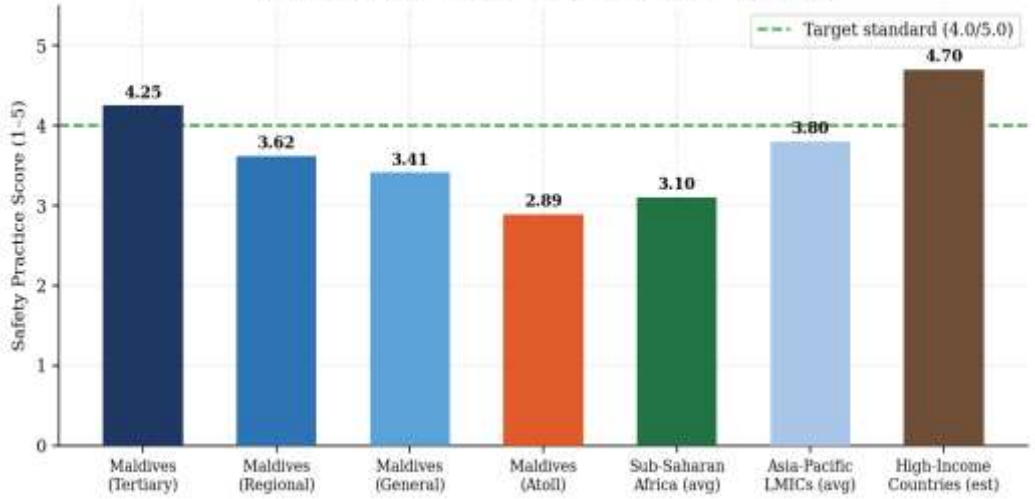

Figure 7: Maldivian radiation safety performance vs. global comparators. Estimated benchmarks derived from published literature. Target standard = 4.0/5.0.

The Maldives falls below the 4.0/5.0 target standard at all facility tiers except the referral hospital. Even tertiary performance (4.25) remains below high-income country benchmarks (~4.7). Atoll performance (2.89) is substantially below sub-Saharan African averages (~3.1), underscoring the compounded disadvantage of archipelagic isolation.

6. RECOMMENDATIONS

Establish a National Radiation Protection Authority: Empower a dedicated body to enact binding safety regulations, conduct mandatory periodic audits, and oversee professional licensing linked to CPD requirements.

National Dosimetry Service: Procure, distribute, and maintain personal dosimeters across all facility tiers on regular calibration cycles, with centralised occupational dose records.

Mandate RSOs and SOPs: Require all imaging facilities to designate qualified Radiation Safety Officers and maintain audited written SOPs as conditions of operating licence.

Institutionalise CPD: Mandate structured CPD linked to registration renewal; deploy digitally delivered programmes for atoll-based professionals.

Equitable Resource Access: Nationally coordinate procurement to guarantee dosimeters, lead aprons, thyroid shields, and gonadal shielding reach all facility tiers.

7. LIMITATIONS

The 45% professional survey response rate and cross-sectional design limit causal inference. Self-reported behaviours are subject to social desirability bias, partially mitigated by triangulation with objective audit data. The facility audit covered 30 of approximately 40 licensed imaging facilities; smaller private clinics may be under-represented. The small Maldivian workforce (n=91 eligible) limits statistical power for subgroup analyses.

8. CONCLUSION

This study provides the first national evidence base for radiation safety in Maldivian medical imaging. A Safety Index of 4.25 at the tertiary referral hospital versus 2.89 at atoll facilities ($F[3,87]=12.47$, $p<0.001$) quantifies the structural inequity in safety readiness. Personal dosimetry is virtually absent (22%), radiation monitoring non-functional at general/atoll facilities (0%), and the national regulatory authority non-existent. CPD and competency explain 48% of safety behaviour variation — confirming that targeted, equitable professional development investment represents the highest-yield individual-level intervention. The empirical baselines established here provide the measurement foundation against which future reform must be held accountable.

REFERENCES

Abbas, A. (2023). Advances in medical imaging: Revolutionizing diagnosis and treatment. https://doi.org/10.31219/osf.io/ydgx9

Abhisheka, B., Biswas, S. K., Purkayastha, B., Das, D., & Esaki, P. (2023). Recent trend in medical imaging modalities and their applications in disease diagnosis: A review. Multimedia Tools and Applications, 82, 43035–43070. https://doi.org/10.1007/s11042-023-17326-1

Adhikari, K. P., Boersma, H. F., Coates, R., Coulor, W., Gallego, E., Omrane, L. B., Suárez, R. C., & Tsegmed, U. (2021). Radiation protection infrastructure — challenges in developing countries. Journal of Radiological Protection, 41(3). https://doi.org/10.1088/1361-6498/ac0c00

Agency, I. A. E. (2023). Handbook of basic quality control tests for diagnostic radiology (IAEA Human Health Series). IAEA. https://doi.org/10.61092/iaea.rhjo-8d0u

Alleyne-Mike, K., Avraham, E., Pierre, L., & Bhookan, S. (2020). Radiotherapy in the Caribbean: A spotlight on the human resource and equipment challenges among CARICOM nations. Human Resources for Health, 18(1), 49. https://doi.org/10.1186/s12960-020-00489-5

Alomairy, N. (2023). Evaluating the knowledge and attitudes towards radiation protection in portable radiological examinations among nurses in pediatric intensive care units. Radioprotection, 59(1), 36–41. https://doi.org/10.1051/radiopro/2023044

Al-Worafi, Y. M. (2024). Radiology and medical imaging education in developing countries. In Springer eBooks (pp. 1–19). Springer Nature. https://doi.org/10.1007/978-3-030-74786-2_579-1

Andersson, B. T., Christensson, L., Jakobsson, U., Fridlund, B., & Broström, A. (2012). Radiographers' self-assessed level and use of competencies — a national survey. Insights into Imaging, 3(6), 635–645. https://doi.org/10.1007/s13244-012-0186-z

Asamani, J. A., Amertil, N. P., Ismaila, H., Francis, A. A., & Nabyonga-Orem, J. (2019). Addressing the healthcare workforce crisis in developing economies. BMJ Global Health, 4(Suppl 9), e001581. https://doi.org/10.1136/bmjgh-2019-001581

Behzadmehr, R., Davoodian, P., Baneshi, M. R., Dehghan Niri, M., Moradi Kohangudaloo, E., & Dashipour, A. (2020). Radiation protection among health care workers: Knowledge, attitude, practice, and clinical recommendations. Reviews on Environmental Health, 35(3), 223–234. https://doi.org/10.1515/reveh-2020-0063

Botwe, B. O., Akudjedu, T. N., Antwi, W. K., Rockson, P., Mkoloma, S. S., Balogun, E. O., & Elshami, W. (2021). Radiography practice and radiation protection in sub-Saharan Africa. Radiography, 27(4), 1145–1153. https://doi.org/10.1016/j.radi.2021.04.009

Bwanga, O. (2020). Barriers to continuing professional development (CPD) in radiography: A review. Radiography, 26(3), e124–e129. https://doi.org/10.1016/j.radi.2019.10.014

Connell, J., & Walton-Roberts, M. (2016). What about the workers? The missing geographies of health care. Progress in Human Geography, 40(2), 158–176. https://doi.org/10.1177/0309132515594489

Creswell, J. W., & Plano Clark, V. L. (2018). Designing and conducting mixed methods research (3rd ed.). SAGE Publications.

DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. American Sociological Review, 48(2), 147–160. https://doi.org/10.2307/2095101

Donkor, A., Wiafe, S., Kachilele, C. C., Dzefi-Tettey, K., Anim-Sampong, S., Darkwa, E. K., Abaka-Yawson, A., & Abushouk, A. I. (2021). Development of the REadiness SElf-assessment (RESEA) guide. BMC Health Services Research, 21, 268. https://doi.org/10.1186/s12913-021-06274-x

Fataftah, J., Al Mousa, D., Al-Bayati, A., & Salih, A. (2024). Awareness of radiation hazards and knowledge of radioprotective measures. The Egyptian Journal of Radiology and Nuclear Medicine, 55(1). https://doi.org/10.1186/s43055-024-01300-4

Frija, G., Blažić, I., Frush, D. P., Hierath, M., Kawooya, M., Donoso-Bach, L., & Brkljačić, B. (2021). How to improve access to medical imaging in low- and middle-income countries? EClinicalMedicine, 38, 101034. https://doi.org/10.1016/j.eclinm.2021.101034

Giammarile, F., Knoll, P., Kunikowska, J., Páez, D., Lobato, E. E., Mikhail-Lette, M., & Wahl, R. L. (2024). Guardians of precision: Advancing radiation protection, safety, and quality systems in nuclear medicine. European Journal of Nuclear Medicine and Molecular Imaging, 51(6), 1498–1505. https://doi.org/10.1007/s00259-024-06633-w

Hillbom, E., Palacio, A., & Tegunimataka, A. (2022). How do small island developing states meet the sustainable development goals? Journal of Sustainable Development, 16(1), 17. https://doi.org/10.5539/jsd.v16n1p17

IAEA. (2023). Patient radiation exposure monitoring in medical imaging. International Atomic Energy Agency.

ICRP. (2024). Ethics in radiological protection for medical diagnosis and treatment. Annals of the ICRP, 53(3), 3–149. https://doi.org/10.1177/01466453231220518

Kawooya, M., Kisembo, H., Remedios, D., Malumba, R., Pérez, M. del R., Ige, T., Hasford, F., & Brown, N. (2022). An Africa point of view on quality and safety in imaging. Insights into Imaging, 13(1). https://doi.org/10.1186/s13244-022-01203-w

Maina, P. M., Motto, J., & Hazell, L. (2020). Investigation of radiation protection and safety measures in Rwandan public hospitals. Journal of Medical Imaging and Radiation Sciences, 51(4), 629–638. https://doi.org/10.1016/j.jmir.2020.07.056

Malone, J. F., Guleria, R., Craven, C., Horton, P., Järvinen, H., Mayo, J., & Czarwinski, R. (2012). Justification of diagnostic medical exposures: Some practical issues. British Journal of Radiology, 85(1013), 523–538. https://doi.org/10.1259/bjr/42893576

Muhogora, W., & Rehani, M. M. (2017). Review of the current status of radiation protection in diagnostic radiology in Africa. Journal of Medical Imaging, 4(3), 031202. https://doi.org/10.1117/1.jmi.4.3.031202

Ng, K. H., Brady, Z., Ng, A. H., Soh, H. S., Chou, Y., & Varma, D. (2021). The status of radiation protection in medicine in the Asia-Pacific region. Journal of Medical Imaging and Radiation Oncology, 65(4), 464–470. https://doi.org/10.1111/1754-9485.13165

Rosenkrantz, A. B., Hughes, D. R., & Duszak, R. (2020). National trends in oncologic diagnostic imaging. Journal of the American College of Radiology, 17(9), 1116–1122. https://doi.org/10.1016/j.jacr.2020.06.001

Scott, W. R. (2014). Institutions and organizations: Ideas, interests, and identities (4th ed.). SAGE Publications.

Shem, S. L., Mshelia, H. D., Garba, N. N., Pam, H. K., & Dogo, P. M. (2022). Challenges, opportunities and strategies of global health radiology in LMICs. Journal of Cancer Prevention & Current Research, 13(1), 14–20. https://doi.org/10.15406/jcpcr.2022.13.00480

UN-OHRLLS. (2015). Small island developing states in numbers — climate change edition 2015. United Nations Office of the High Representative for Least Developed Countries.

Wang, J., Lin, L., Bhargava, A., Schroeder, B., Chong, N., Kuszyk, B., & Bhargava, P. (2025). The need for evidence-based, outcome-focused medical imaging research for cancer management. npj Imaging. https://doi.org/10.1038/s44303-024-00067-7

Yuan, J., Liu, D., & Ni, J. (2024). Assessment of radiation knowledge and awareness among radiology staff in tertiary hospitals. Radioprotection, 59(3), 184–188. https://doi.org/10.1051/radiopro/2024002

Zarei, F., Dehghani, A., Ratansiri, A., Ghaffari, M., Raina, S. K., Halimi, A., & Rakhshande, H. (2023). Radiation safety management and protection in radiology departments. Radiation Protection Dosimetry, 199(3), 213–221. https://doi.org/10.1093/rpd/ncac284