



Original Article

Establishment of Local Diagnostic Reference Levels for Pediatric Head CT at a South African Tertiary Hospital

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Abstract: Computed tomography (CT) provides rapid, high-resolution 3D imaging, reducing motion artifacts and the need for sedation in pediatric patients. However, children are highly sensitive to ionizing radiation due to their developing tissues and longer life expectancy. This study proposed local diagnostic reference levels (LDRLs) for pediatric head CT examinations at a South African (SA) tertiary hospital. A retrospective review was conducted for pediatric head CT dose length product (DLP) and volume computed tomography dose index (CTDI_{vol}) data acquired between January 2023 and March 2024. Examinations were stratified into four age groups: <1 year, 1 – <5 years, 5 – <10 years, and 10 – 15 years. For each group, median DLP and CTDI_{vol} values were calculated as LDRLs and then compared with international values. Proposed LDRLs in terms of DLP (mGy.cm) were 242.6; 405.5; 715.5 and 899.3 while in terms of CTDI_{vol} (mGy) were: 13.8; 15.8; 26.0 and 38.7 respectively for <1 year; 1 – <5 years; 5 – <10 years and 10 – 15 years age groups. The DLP for SA (242.6) exceeded Brazilian (143.8) but was lower than Nigerian (1040.0) for <1-year group. For 1 – <5 years, the DLP for SA (405.5) was lower than Nigerian (988.0), yet higher than Iranian (216.9). For 5 – <10-year group, the DLP for SA (715.5) exceeded Iranian (232.8) but remained lower than Nigerian (1493.0). For 10 – 15-year group, the DLP for SA (899.3) surpassed Omani (391.0) and Brazilian (531.7) but remained lower than Nigerian (1824.0). In case of CTDI_{vol} (mGy) for <1-year group, SA (13.8) value exceeded Brazilian (8.8) and Omani (13.0) values. For 1 – <5 years, SA (15.8) value remained lower than Saudi Arabian (22.0) value. For 5 – <10 years, the SA (26.0) value exceeded the Omani (19.0) value but remained lower than Saudi Arabian (29.0). For the 10 – 15 years the SA (38.7) value exceeded the Brazilian (26.9) and Omani (21.0) values but remained lower than the Irish (52.1) value. Pediatric CT doses at the proposed South African tertiary hospital fall within global ranges. However, higher values in the <1, 5 – <10, and 10 – 15-year groups compared to some international values indicate room for possible optimization.

Keywords: pediatric CT, radiation dose optimization, dose length product (DLP), computed tomography.



Establecimiento de Niveles Locales de Referencia Diagnóstica para TC de Cabeza Pediátrica en un Hospital Terciario Sudafricano

Resumen: La tomografía computarizada (TC) proporciona imágenes tridimensionales rápidas y de alta resolución, reduciendo los artefactos por movimiento y la necesidad de sedación en pacientes pediátricos. Sin embargo, los niños son altamente sensibles a la radiación ionizante debido al desarrollo de sus tejidos y a su mayor esperanza de vida. Este estudio propuso niveles locales de referencia diagnóstica (LDRLs) para exámenes de TC de cabeza pediátrica en un hospital terciario de Sudáfrica (SA). Se realizó una revisión retrospectiva de los datos del producto dosis-longitud (DLP) y del índice volumétrico de dosis en tomografía computarizada ($CTDI_{vol}$) obtenidos entre enero de 2023 y marzo de 2024. Los exámenes se clasificaron en cuatro grupos etarios: <1 año, 1 – <5 años, 5 – <10 años y 10 – 15 años. Para cada grupo, se calcularon los valores medianos de DLP y $CTDI_{vol}$ como LDRLs y posteriormente se compararon con valores internacionales. Los LDRLs propuestos en términos de DLP (mGy.cm) fueron 242.6; 405.5; 715.5 y 899.3, mientras que en términos de $CTDI_{vol}$ (mGy) fueron 13.8; 15.8; 26.0 y 38.7 respectivamente para los grupos etarios <1 año; 1 – <5 años; 5 – <10 años y 10 – 15 años. El DLP para SA (242.6) superó al de Brasil (143.8), pero fue inferior al de Nigeria (1040.0) en el grupo <1 año. Para el grupo de 1 – <5 años, el DLP de SA (405.5) fue menor que el de Nigeria (988.0), aunque superior al de Irán (216.9). En el grupo de 5 – <10 años, el DLP de SA (715.5) superó al de Irán (232.8), pero permaneció inferior al de Nigeria (1493.0). Para el grupo de 10 – 15 años, el DLP de SA (899.3) superó los valores de Omán (391.0) y Brasil (531.7), aunque permaneció inferior al de Nigeria (1824.0). En cuanto al $CTDI_{vol}$ (mGy), para el grupo <1 año, el valor de SA (13.8) superó los valores de Brasil (8.8) y Omán (13.0). Para el grupo de 1 – <5 años, el valor de SA (15.8) fue inferior al de Arabia Saudita (22.0). Para el grupo de 5 – <10 años, el valor de SA (26.0) superó el valor de Omán (19.0), pero permaneció inferior al de Arabia Saudita (29.0). Para el grupo de 10 – 15 años, el valor de SA (38.7) superó los valores de Brasil (26.9) y Omán (21.0), aunque permaneció inferior al valor de Irlanda (52.1). Las dosis de TC pediátrica en el hospital terciario sudafricano propuesto se encuentran dentro de los rangos globales. Sin embargo, los valores más altos observados en los grupos <1, 5 – <10 y 10 – 15 años en comparación con algunos valores internacionales indican la posibilidad de optimización adicional.

Palabras clave: TC pediátrica, optimización de dosis de radiación, producto dosis-longitud (DLP), tomografía computarizada.

1. INTRODUCTION

Computed Tomography (CT) is a powerful imaging modality that generates high-resolution, three-dimensional images by acquiring multiple x-ray projections around the patient and reconstructing them into axial slices [1]. A single slice can enable physicians to study human bones, soft tissues and blood vessels [2]. This capability has revolutionized diagnostic medicine. The x-rays used in image formation are a form of ionizing radiation [3]. Despite the beneficial use of pediatric CT, there are concerns that children are more sensitive to ionizing radiation compared to adults [2, 4]. The sensitivity of children is attributed to their growing tissues and small organs, factors that increase the probability of long-term stochastic effects [5]. Furthermore, children have a longer lifespan to manifest the effects of radiation exposure when compared to adults. This is further exacerbated by the fact that children are more likely to undergo repetitive scanning throughout their life time [6]. These factors emphasize the importance of dose optimization in pediatric CT imaging. Efforts to improve patient safety culminated with the introduction of diagnostic reference levels (DRLs), also regarded as optimal doses [7].

DRLs can be viewed as an investigative tool that aids identification of examinations that expose patients to radiological doses that are higher than optimal values established as national or international values. However, when radiological doses are substantially lower than established national or international reference levels, this may indicate potential underexposure, which could compromise image quality and diagnostic reliability. This relationship is not absolute, as lower doses may still be clinically acceptable depending on imaging protocols, technology and optimisation strategies [8]. The American Association of Physicists in Medicine has traditionally supported the use of $CTDI_{vol}$ and DLP as standardized dose descriptors for DRL establishment [9]. However, subsequent reports (AAPM Reports 204, 220, and 293) emphasize the limitations of $CTDI_{vol}$ as a phantom-based metric and recommend the use of size-specific dose estimate (SSDE) as a more

patient-centered dosimetric quantity that incorporates patient size and attenuation, thereby improving dose characterization for optimization purposes [10,11,12].

The $CTDI_{vol}$ quantifies the average dose per slice measured in mGy while the DLP is the total energy absorbed along the scan length and is measured in mGy.cm [9, 13]. The DRLs may be established at local, provincial and national level [14], and specific to a country or region [15]. They are based on a defined clinical imaging task (i.e., a common indication-based protocol) surveyed for standardized patient groupings, at least 30 for CT. Local DRLs (LDRLs) can be established within a department or several departments in a large hospital [16]. For LDRLs, it is recommended that there should be at least data for 30 patients for CT and other high dose imaging modalities. For a large hospital with several radiological departments, the LDRL is considered as the 75th percentile of dose distributions of patient doses for a determined clinical task [14]. However, where there is one department, the LDRL becomes the median of the dose distributions [16].

Many developing countries including South Africa lack locally established DRLs for pediatric CT examinations. This gap hinders efforts to assess and optimize radiation practices within local contexts. Therefore, the objective of this study was to establish LDRLs for pediatric head CT examinations in a South African tertiary hospital. The proposed LDRLs are intended to inform national standards and contribute to improved radiation safety in pediatric imaging.

2. MATERIALS AND METHODS

A retrospective study approved by the local university Ethics Committee (clearance reference number: SMUREC/M/140/2023: PG). The study was conducted in the radiology department of a tertiary hospital from January 2023 to March 2024. Only data for pediatric head CT examinations were included. Data were acquired by a 128 multi-slice Ingenuity Core (Philips, Koninklijke, Amsterdam, The Netherlands) equipped with iterative

reconstruction technique software (Ingenuity128 with iDose4). All examinations were performed using Automatic Exposure Control (AEC) system, specifically tube current modulation (mA modulation), as implemented by the manufacturer. Patient identification numbers obtained from the Radiological Information System (RIS) were used to retrieve data corresponding to each patient from the Picture Archiving System (PACS).

Data for pediatric patients with missing information and those who were administered with contrast medium were excluded to eliminate dose outliers. The data collected included patient age, gender, CT scanner model and technical scan parameters: tube current (mAs), and tube voltage (kVp). Exposure parameters (kVp and mAs) were standardized according to age-based institutional protocols. All data were anonymized and entered in standard Microsoft Excel spreadsheets (Microsoft Corporation, Redmond, WA, USA). Other parameters, such as pitch, slice thickness, scan length, and reconstruction kernel, were not uniformly recorded in the imaging archives and were therefore not included in the analysis. Furthermore, clinical indications were excluded as they were not consistently available in the extracted dataset. Therefore, the analysis was based on protocol classification rather than indication-specific categorization. All examinations corresponded to routine non-contrast head CT protocols, which are typically used in pediatric populations for trauma, seizure evaluation, and hydrocephalus assessment.

The study included included pediatric patients aged < 1 year – 15 years who underwent head CT examinations during the study period. Patients were stratified into four age groups: <1 year, 1–<5 years, 5–<10 years, and 10–15 years, in accordance with established pediatric grouping for Diagnostic Reference Level (DRL) studies [14]. Grouping by age was adopted instead of weight, in line with recommendations by Vassileva et al [17], in the absence of patient weight. A total of 40 CT pediatric CT examinations were included. The number of patients in each group was as follows: (< 1 year, n =10); (1 – < 5 years, n=10); (5 – < 10 years, n=10) and (10 – 15 years, n= 10).

Table 1 Scan parameters for CT examinations for the four paediatric age groups

AGE GROUP YEARS	n	TUBE CURRENT-TIME (mAs)				TUBE VOLTAGE kVp
		MIN	MAX	MEAN	IQR	
< 1	10	150	200	184.5	50	100
1 - < 5	10	180	296	198	116	100
5 - < 10	10	110	315	230	205	100
10 -15	10	175	733	278	558	100

For each scan, the DLP and CTDI_{vol} were recorded. DLP and CTDI_{vol} values were stratified by age groups (< 1 year; 1 – < 5 years; 5 – < 10 years; and 10 – 15 years), following the guidelines of ICRP Publication 135 [14]. Descriptive statistics were used to summarize the dataset. The median DLP and CTDI_{vol} values for each age group were calculated and proposed as LDRLs while the 75th percentile of DLP and CTDI_{vol} values were suggested as national DRLs (NDRLs). LDRLs were compared with international values.

3. RESULTS AND DISCUSSIONS

3.1 Patient demographics and scan parameters

CT doses were collected for 40 pediatric patients (both male and female) who underwent head CT examinations at a tertiary hospital between January 2023 to March 2024. The mean age of pediatric patients was 7.2 years (7.3 years for males and 7.2 years for females). All scans were performed using a fixed tube voltage of 100 kVp. However, the tube current-time product (mAs) varied across different age groups, as illustrated in Table 1.

The mean tube current-time (Table 1) for the < 1-year age group was 184.5 mAs it ranged from 150 mAs to 200 mAs. For the age group (1 – < 5 years), the mean was 198 mAs and it ranged from 180 mAs to 296 mAs. For the age group 5 – < 10 years, the mean was 230 mAs and it from 110 mAs to 315 mAs. For the age group 10 – 15 years, the mean was 278 mAs and it ranged from 175 mAs to 733 mAs.

3.2 Recommended local Diagnostic Reference Levels for the tertiary hospital

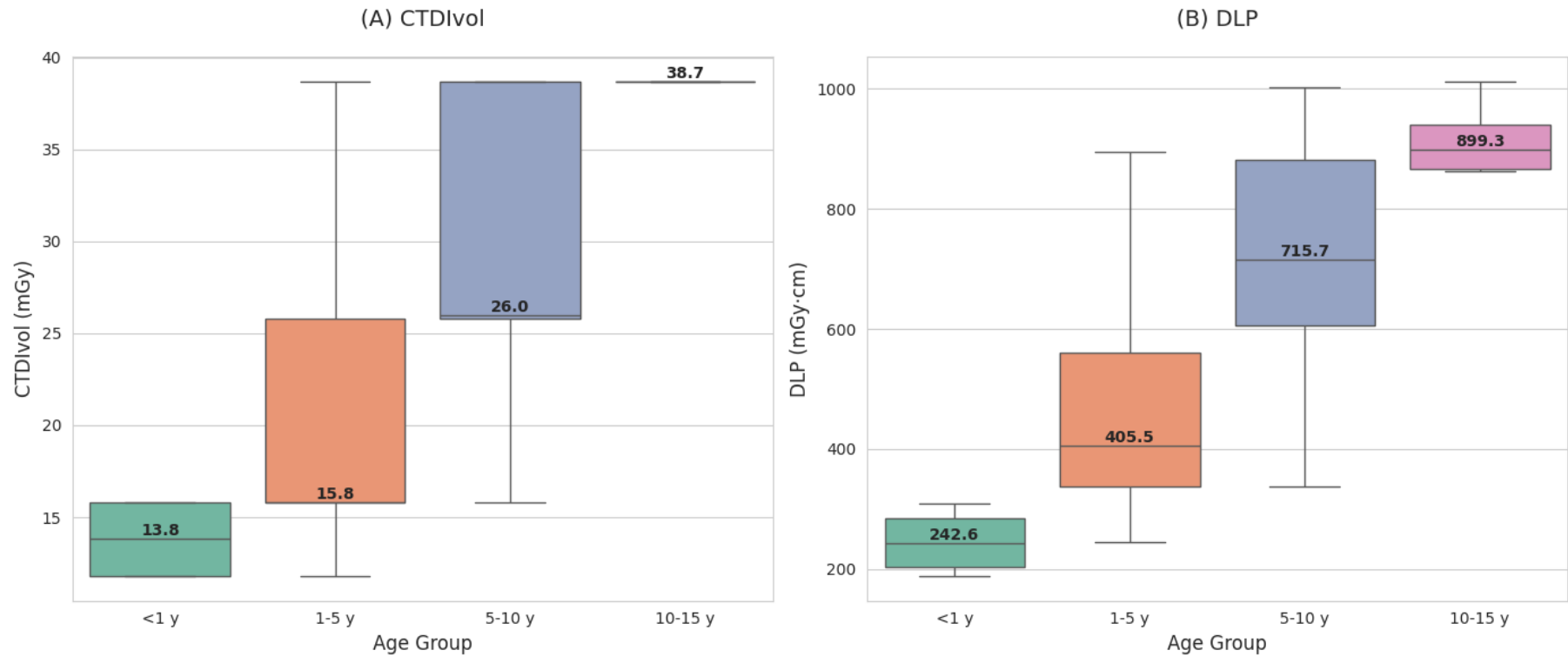
The recommended LDRLs in terms of $CTDI_{vol}$ and DLP for pediatric head CT examinations are summarized in Table 2. These include minimum, maximum, median (50th percentile) and 75th percentile values for each pediatric age group. Median $CTDI_{vol}$ and DLP represent LDRLs, while the 75th percentiles are suggested as NDRLs.

In Figure 1, A illustrates variation for $CTDI_{vol}$ while B illustrates variation of DLP across four age groups (<1 year, 1–<5 years, 5–<10 years, and 10–15 years) for pediatric head CT examinations at a South African tertiary hospital.

Table 2 Local Diagnostic Reference Levels in terms of $CTDI_{vol}$ and DLP

AGE GROUP YEARS	$CTDI_{VOL}$ (mGy)				DLP (mGy.cm)			
	MIN	MAX	MEDIAN	75 TH PERCENTILE	MIN	MAX	MEDIAN	75 TH PERCENTILE
< 1	11.8	15.8	13.8	15.8	188.5	309.2	242.6	301.0
1 - < 5	11.8	37.8	15.8	26.4	245.2	894.8	405.5	593.0
5 - < 10	15.8	38.7	26.0	38.7	338.4	1355.0	715.7	883.0
10 -15	25.8	116.7	38.7	39.4	610.3	2653.4	899.3	968.0

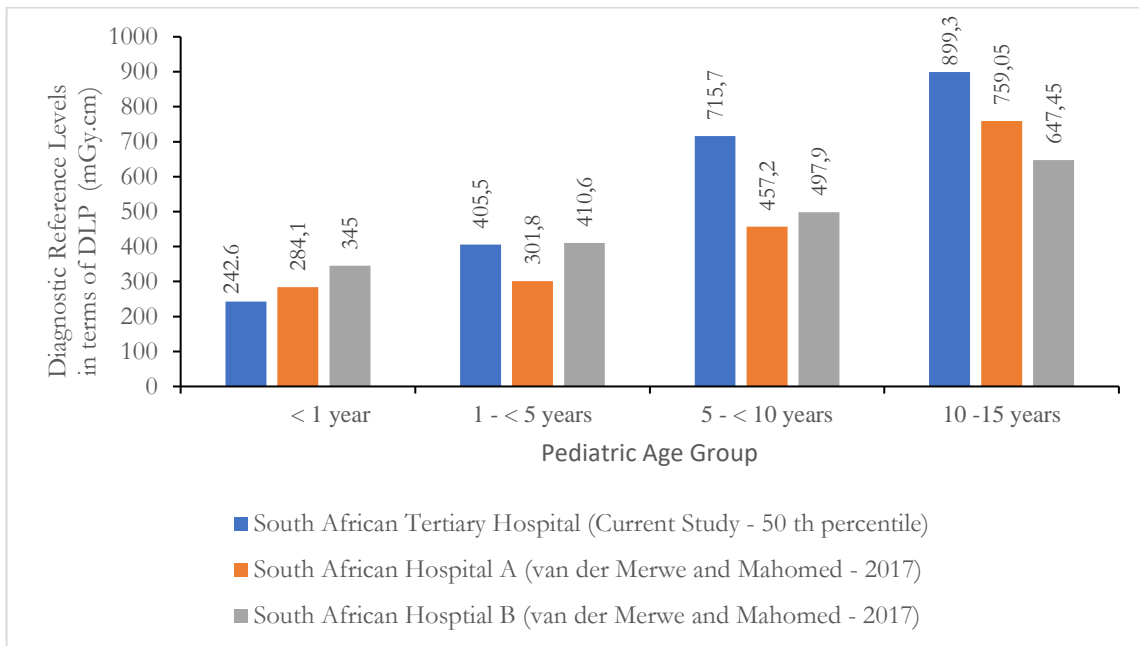
Figure 1: Median CTDIvol (A) and DLP (B) values for pediatric head CT examinations across four age groups.



3.2.1 Comparison of the Study Centre’s DRLs in terms of DLP with other DRLs established in two South African hospitals.

Figure 2 compares the median DLP values for the current study with those reported from two South African hospitals.

Figure 2: Comparison of DLP values for head CT examinations in three South African hospitals.

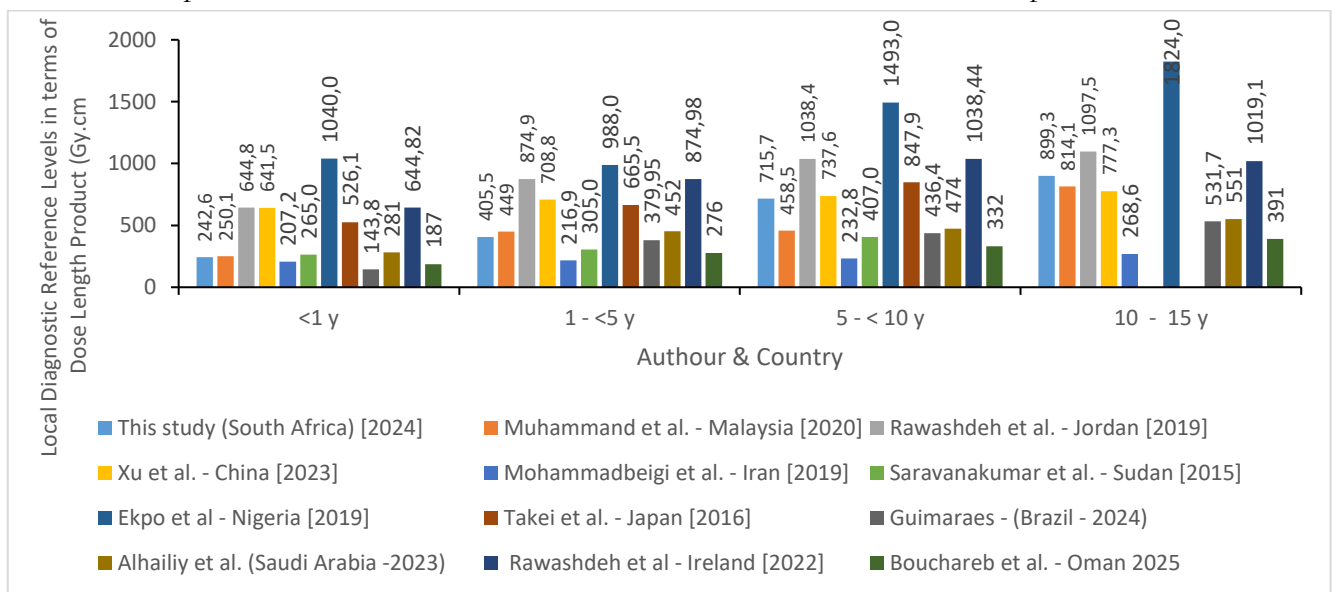


For the current study, the DLP (242.6 mGy.cm), Figure 2, was lower than that of hospital B (345 mGy.cm) and hospital A (284.1 mGy.cm) for the <1year age group. However, in the older age groups, (1 – < 5 years), it was higher than DLP values for hospital A (405.5 vs 301.8 mGy.cm) but lower than DLP values for hospital B (405.5 vs 410.6 mGy.cm). For the age group 5 – < 10 years, it remained higher than values established in hospitals A and B (715.7 vs 457.2 mGy.cm and 497.9 vs 497.9 mGy.cm respectively). For the age group 10 – 15 years it was even much higher than the DRLs for A and B (899.3 vs 759.05mGy.cm and 899.3 vs 647.45 mGy.cm respectively) [18].

3.2.2 Comparison of the pediatric head CT examinations diagnostic reference levels in terms of DLP with international values

Figure 3 provides a snap overview of LDRLs in terms of DLP for pediatric head CT examinations established in a South African context (current study) in comparison to LDRLs for similar protocols in some selected international countries.

Figure 3: Comparison of LDRLs established at a South African tertiary hospital in terms of DLP for pediatric head CT examinations with international values for similar protocols.



The LDRLs in terms of DLP in the current study (242.6 mGy.cm), Figure 3 for the <1-year age group was found to be higher than that established in Lithuania (144.3 mGy.cm) [2], Iran (207.2 mGy.cm) [19], Brazil (143.8 mGy.cm) [20] and Oman (187.0 mGy.cm) [21], indicating a room for further optimization. However, it remained lower the values established in Malaysia (250.1 mGy.cm) [22], Jordan (644.8 mGy.cm) [23] and Nigeria (1040.0 mGy.cm) [24].

For older children, the DRLs in terms of DLP showed an increasing trend. In the 1– <5 years group, the current study value (405.5 mGy.cm) was found to be lower than international values; Malaysia (449.0 mGy.cm) [22], Jordan (874.9 mGy.cm) [23] and Nigeria

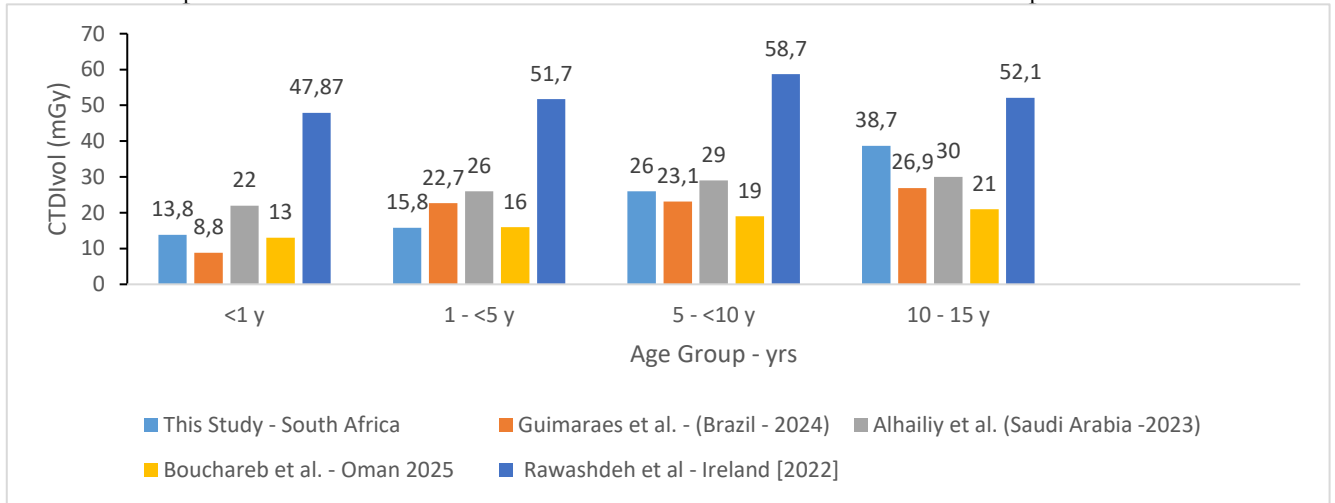
(988.0 mGy.cm) [24], but higher than values established in Lithuania (233.7 mGy.cm) [2], Iran (216.9 mGy.cm) [19], Brazil (380 mGy.cm) [20] and Oman (276.0 mGy.cm) [21]

For the 5 – <10 years group, the current study DRL in terms of DLP (715.7 mGy.cm) was again lower than values established in Jordan (1038.4 mGy.cm) [23] and values established in Nigeria (1493.0 mGy.cm) [24]. However, it was higher than values established in Lithuania (246.4 mGy.cm) [2], Iran (216.9 mGy.cm) [19], Brazil (436.4 mGy.cm) [20], Oman (332 mGy.cm) [21] and Saudi Arabia (474.0 mGy.cm) [25], indicating a room for improvement. For the 10 – 15 years+ the current study DRL in terms of DLP (899.3 mGy.cm) was lower than the values established in Jordan (1097.5 mGy.cm) [23] and Nigeria (1824.0 mGy.cm) [24] and and Ireland (1038.4 mGy.cm) [26]. However, the DRLs were higher than values established in Oman (391 mGy.cm) [21], Saudi Arabia (551 mGy.cm) [25] and Brazil (531.7 mGy.cm) [20], indicating room for possible improvement of our DRLs. Overall, the findings suggest that South African pediatric DRLs in terms of DLP for the head CT examinations are generally comparable to international protocols and in some cases lower than those reported in high-exposure settings such as Nigeria [24].

3.2.3 Comparison of the pediatric head CT examinations diagnostic reference levels in terms of $CTDI_{vol}$ with international values

Figure 4 provides a snap overview of LDRLs in terms of $CTDI_{vol}$ for pediatric head CT examination established in a South African context (current study) in comparison to LDRLs for similar protocols in some selected international countries.

Figure 4: Comparison of LDRLs established at a South African tertiary hospital in terms of CTDI_{vol} for pediatric head CT examinations with international values for similar protocols.



The LDRL in terms of CTDI_{vol} for the current study (13.8 mGy), Figure 4 for the <1-year age group is higher than that established Brazil (8.8 mGy) [20] and Oman (13.0 mGy) [21], indicating that there still exist a room for further optimization of the SA protocol. However, it remained lower than values established in Saudi Arabia (22.0 mGy) [25] and Ireland (47.8 mGy) [26]. For older children, the DRLs in terms of CTDI_{vol} showed an increasing trend. In the case of the 1 – <5 years group, the current study value (15.8 mGy) was found to be lower than international values; Brazil (22.7 mGy) [20], Saudi Arabia (26 mGy) [25] and Oman DRL (16.0 mGy) [21], implying that the DRLs at our centre are optimized. For the 5 – <10 years group, the current study DRL (26 mGy) was again higher than the value established in Brazil (23.1 mGy) [20] and Oman (19.0 mGy) [21], indicating room for possible optimization. However, it was higher than Saudi Arabian (29 mGy) [25] and the Ireland (58.7 mGy) [26]. For the 10 – 15 years, the current study DRL in terms of CTDI_{vol} (38.7 mGy) was lower than the Ireland DRL (52.1 mGy) [26]. However, it was higher than other international values; Brazil (26.9 mGy) [20], Oman DRL (21.0 mGy) [21] and Saudi Arabian (30 mGy) [25] hence the need for possible optimization. Overall, the findings suggest that South African pediatric DRLs in terms of CTDI_{vol} and DLP values for the head CT examinations are generally comparable to international protocols.

3.3 Discussion

This study established Local Diagnostic Reference Levels (LDRLs) in terms of DLP and CTDI_{vol} for pediatric head CT examinations in a South African tertiary hospital. The limited number of pediatric cases made it difficult to derive highly robust DRLs. Hamad et al. [27] also reported that the scarcity of regional and international pediatric CT data remains a major challenge for dose optimization. Vassileva and Rehani [17] further showed that small sample sizes can influence median dose values, especially in infants, due to greater variability. Despite this limitation, the inclusion of 10 patients per age group meets minimum international recommendations and supports the validity of the reported DRLs [27].

The tube voltage was fixed at 100 kVp across all age groups, while mAs varied (Figure 1). This variation reflects appropriate protocol adjustment and radiographer awareness. However, a high mAs value of 733 mAs was observed in the 10 – 15-year group. This may be explained by the influence of automatic exposure control (AEC) and increased patient size. Larger adolescents require higher tube current to compensate for attenuation. The possible use of adult protocols in this group may also have contributed to higher dose values. Muhammad et al. [22] emphasized that CT parameters must be adapted to patient size and age to achieve optimal dose reduction. As expected, variations in mAs and scan length resulted in increasing DLP values with age (Figure 1B), which agrees with previous findings [28, 29].

Comparison with other South African hospitals showed notable variation in DLP across all age groups (Figure 2) [15]. These differences reflect the influence of pediatric body size and protocol selection, as described by Xu et al. [30]. The lower DLP observed in the <1-year group in this study (242.6 mGy·cm) compared to Hospital A and B may be due to the use of a more advanced 128-slice CT scanner. In contrast, the other hospitals used 64-slice systems [15]. For older age groups, however, Hospitals A and B reported lower DRLs. This may be due to differences in clinical practice. A dedicated pediatric hospital is more

likely to apply optimized pediatric protocols. In mixed clinical settings, where both adult and pediatric imaging are performed, there is a higher risk of suboptimal parameter adjustment.

International comparison (Figure 3) shows that the <1-year DLP in this study (242.6 mGy·cm) is higher than values reported in Lithuania [2], Iran [19], Brazil [20], and Oman [21], but lower than those from Malaysia [22], Jordan [23], and Nigeria [24]. These differences are attributed to variations in scanner models, acquisition parameters, and clinical practices [3]. In this study, kVp remained constant while mAs increased with age (Table 1). In contrast, the Malaysian study used both higher mAs and higher kVp values, reaching up to 120 kVp in older children [22]. The combination of high kVp and high mAs significantly increases radiation dose, explaining the higher reported values.

Differences in $CTDI_{vol}$ across age groups and between studies are mainly due to variations in mAs and kVp. The mAs is the main determinant of radiation dose. Higher mAs values increase $CTDI_{vol}$, especially when modulation is not optimized. The slightly higher $CTDI_{vol}$ in the <1-year group compared to Brazil [20] and Oman [21] may reflect conservative parameter selection to preserve image quality. However, lower values compared to Saudi Arabia [25] and Ireland [26] suggest some level of optimization. The increase in $CTDI_{vol}$ with age (Figure 1A) is expected due to increased body size and attenuation, which require higher exposure settings.

Scanner technology and protocol optimization also contribute to dose variation. Modern CT systems with AEC and iterative reconstruction can reduce radiation dose while maintaining image quality. Higher $CTDI_{vol}$ values observed in older age groups compared to Brazil [21] and Oman [22] may indicate less effective AEC use or higher fixed kVp settings. These findings confirm that dose variation is influenced not only by patient size but also by technology and protocol design. Continuous protocol review and optimization are therefore essential to align with international standards [20,21,25,26]. Future research should include larger, multicentre datasets, incorporation of size-based metrics, and development of national pediatric DRLs to improve radiation protection.

4. LIMITATIONS

This study is limited by its retrospective design and relatively small sample size per age group, which, although consistent with international recommendations, may affect the statistical robustness of the derived DRLs. The absence of patient size metrics (e.g., effective diameter or SSDE) and incomplete acquisition parameters (such as pitch, slice thickness, scan length, and reconstruction kernel) further constrained detailed dose optimization and inter-scanner comparisons. The absence of indication-specific data represents yet another limitation. While clinical indication can influence scan length and, in some cases, acquisition parameters, previous studies have shown that standardized head CT protocols particularly in tend to exhibit minimal variation across common indications such as trauma and seizure evaluation [[31]. Therefore, the reported dose metrics are considered representative of routine clinical practice within the institution. Furthermore, the use of $CTDI_{vol}$ a standardized and widely accepted dose descriptor ensures that the findings remain representative of routine clinical practice. Lastly, the other limitation was that there was no formal radiologist-led image quality assessment performed. However, all images were considered diagnostically acceptable in routine clinical practice. Future work should incorporate structured image quality evaluation to ensure that dose optimization does not compromise diagnostic performance.

5. CONCLUSIONS

This study successfully established local DRLs for pediatric head CT examinations in a South African tertiary hospital. The results show that dose optimization has been achieved in certain age groups, particularly infants. However, higher-than-benchmark DRLs in older children indicate opportunities for improvement. Comparisons of local and international studies revealed variations attributable to differences in CT scanner specifications, scanning protocols, and radiographer practices. The findings highlight the critical role of consistent

protocol review, age- and size-specific parameter adjustment, and dedicated pediatric imaging practices in achieving sustainable dose optimization. Future studies should incorporate larger, multicentre datasets, include size-based dose metrics, and support the development of national pediatric DRLs to enhance dose optimization and radiation protection in pediatric CT imaging.

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CONTRIBUTORSHIP

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Investigation: MN, ADRM

Writing – review and editing: MN

CONFLICT OF INTEREST

We have no conflicts of interest to disclose.

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