Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 13 [1] December 2023 :256-265

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
ORIGINAL ARTICLE **OPEN ACCESS**

Estimation of dose length product (DLP) using MSCT for CT Chest based on sex and body weight in north India

Maajid Mohi Ud Din Malik
Department of Radiology, School of Medical and Allied Sciences, GD Goenka University Gurgram Haryana India 122130.
Email: Majidmalik343@gmail.com ,
Orcid Id: https://orcid.org/0000-0003-1743-1520

ABSTRACT
This study aimed to determine the DLP for Chest computed tomography (CT) in North India. DLP was collected from 10 CT scanners from 10 different places in north India. DLP was collected from 30 successive Chest CTs in each centre. The analysis showed significant dosage differences between the CT scanners, with the DLP having a 159-1101.6 mGy/ cm range. Changes in the mAs and kVp were linked to differences. The necessity for dosage optimisation was highlighted by the study's confirmation of significant DLP variability for chest CT images, which was linked to acquisition techniques. To examine the importance of sex and body weight (BW) in dose length products (DLP) based on radiation dose monitoring. To estimate patient doses in the chest examination using computed tomography and calculate organ dose. Three hundred (300) single-phase (plain or unenhanced) computed tomography examinations of the chest were performed from 15 March 2022 to 30 September 2022 on 10 different scanners and were analysed. This study included a total of 300 (n=300) participants who were referred for a chest CT scan and ranged in age from 18 to 90. With a minimum age of 18 years and a maximum age of 89, the average age of the 300 participants (189 men and 119 women) was 53.34 ± 16.53 years. The patient's average body weight ranged from 50.0 to 90.0, with a mean of 67.75 ± 7.36. With a maximum DLP of 1101.64 and a minimum DLP of 159 mGy X cm, the average DLP for the 300 participants was 518.89 ± 227.97 mGy X cm. Using the conversion factors provided by the European Commission, the effective dose was computed from the DLP of each examination, yielding a mean value of 7.33 ± 3.26 mSv with a high of 15.414 and a minimum of 2.226 mSv. This study shows the importance of gender and Bodyweight while using DLP to track radiation exposure during Chest CT. Size increased the DLP for men and women. Radiation exposure during imaging correlates with DLP sex and body weight. Controlling for patient sex and BMI makes the DLP more similar amongst scanners and imaging modalities. The change helps detect radiation dose changes. DLP and ED for the standard chest examination were well below European Commission recommendations (EC). The diagnostic picture quality was unaffected by the Chest examination's lower DLP and effective Dose than the EC.
Keywords: *CT, DLP,* $CTDI_{VOL}$*, India, ED*

Received 01.10.2023 Revised 20.10.2023 Accepted 04.12.2023

INTRODUCTION

Introduced in the early 1970s, CT has since been a crucial part of medical practice. It has evolved into a powerful and versatile diagnostic tool and has already supplanted several radiologic procedures[1,2]. Along with helical and multiple slice configuration development, CT applications have advanced [3]. However, the potential for cancer development is a worry because of the relatively high radiation exposures associated with CT scans [4,5]. CT examinations for targeted therapeutic purposes necessitate recording high-quality images without subjecting patients to excessive radiation. Modern CT scanners also use techniques that dramatically alter the radiation dose provided to the patient and provide a wide range of exposure variables 6. When a radiological examination is required due to a valid clinical indication 7,8, all necessary precautions must be taken to ensure the patient's and the staff's safety from ionising radiation and the security of the radiation source itself, following international basic safety standards. Even while it is now common knowledge that CT scanning exposes patients to a substantial amount of radiation, this was not always the case. When whole-body CT first became available, it was mainly applied to cancer patients, for whom radiation exposure posed less risk given the relative hazards[9]. CT of the brain, however, was unrivalled by any other modality in terms of diagnostic accuracy. Radiation protection concerns are more important for young patients and those with benign diseases who use CT often today [9,10]. The ICPR has urged a shift in focus to CT dose reduction efforts.ICRP, IAEA, and the EC have all recommended establishing and enforcing CT dose guideline levels for the most common CT scans to enhance radiation dose optimisation strategies [11]. The most common CT dose quantity is the Computed Tomography Dose Index (CTDI), calculated by summing the Dose along the long axis from a single X-ray tube rotation and a single CT slice. Dose length product (DLP) comprises both patient and phantom volume irradiated throughout a complicated exam, which is another crucial dose quantity.

RADIATION DOSE DATA

Estimating the average phantom dosage for a full spiral CT scan, $CTDI_{VOL}$ is calculated by dividing the weighted CTDI (CTDIW) by the CT pitch. $CTDI_{VOL}$ and DLP are standard on modern CT scanners so that you can switch between them anytime throughout your scan. Dose calculations required exposure and procedure information on previous machines. Each patient's CTDIVOL and DLP values were taken directly from the medical imaging archive (PACS). The two essential dosage parameters and their respective calculation procedures are summarised here. In a personal examination, reducing radiation increases image noise, degrading image quality. It is believed that increasing radiation exposure through computed tomography (CT) will increase the risk of developing cancer, and this issue is well acknowledged in modern medicine,12,13,14. AEC and iterative (IR) image reconstruction are two examples of the ongoing research and development of dose reduction methods that aim to lower radiation dose without sacrificing image quality[15,16]. The radiation dose for the relevant protocol must be evaluated to optimise the data collection and reconstruction approaches. For dosage reduction, thorough dose tracking is crucial, and different solutions are available17,18. Daily radiation dose monitoring is also desired to identify and steer clear of unforeseen, excessive radiation exposure. Increasing size causes the tissues to attenuate more X-ray photons, reducing the number of photons detected. The tube current for X-ray emission is often modulated using AEC[19,20] to obtain CT images of consistent quality. In a large patient, CTDIvol rises due to higher tube current, and a considerable body height may also lengthen the scan. Consequently, a large patient's DLP value may be unavoidably high [21]. Identifying improper, excessive radiation exposure in individual exams is hampered by such a difference in the DLP according to body size. Additionally, different regions of the world have varying standards for body size, which could skew global radiation dose comparisons. This study examined the importance of body weight and sex in DLP-based radiation dose monitoring. The ongoing study compared body weight and DLP values for Chest CT scan done on ten different CT scanners. Men and women underwent the analysis independently.

OBJECTIVE

- To investigate the significance of sex and body weight (BW) in dose length products (DLP) based on radiation dose monitoring.
- To estimate patient doses in the chest examination using computed tomography and calculate organ dose.
- To compare radiation dose using different computed tomography (CT) scanners in males and females.

MATERIAL AND METHODS

Subjects

From 15 March 2022 to 30 September 2022, 300 single-phase (plain or enhanced) chest CT scans were done on 10 scanners and analysed. The following inclusion criteria were applied:

Study population

- All records with requests for a Chest scan. The data has been collected from DICOM.

The inclusion criteria were:

- Adults aged 18-90 years
- Weight between 45-90 kg.
- Both genders.

Sample Adult DLP Data Collection at Different Centers

Age Group 18-80 Years

Sr. No	Chest (DLP in mSv)
DLP	30 Cases

Exclusion criteria

The Exclusion Criteria were:

- Weight between > 90 kg
- Adults aged < 18 years

Statistical analysis

Range, mean, standard deviation (SD), median, frequencies (number of cases), and relative frequencies (percentages), where applicable, will be used to characterise the data. The statistical tool SPSS 21version for Microsoft Windows and XLSTAT 2022 was used for all statistical calculations.

RESULT

The research was conducted in North India, including 10 (ten) CT scanners. The data was collected from DICOM and analysed. A total number of three hundred (n=300) patients within the age range of 18-90 who were referred for a CT scan of the chest were included in this research. One hundred nineteen (119) were females, while one eighty-one (181) were males, as shown in Table 1. The average age of the 300 patients was 53.34 ±16.53 years, with a maximum age of 89 and a minimum age of 18.0 years. The patients' average weight was 67.75 ± 7.36 Kg, with a maximum of 90 and a minimum of 50.0. The effective Dose was calculated from the DLP of each examination using the European Commission's conversion factors and ranged from 12.7 mSv to 1.6 mSv, with a mean value of 5.4 ± 2.4 mSv.

Table 1: Summary statistics

Radiation dose parameters in CT chest					
Particulars	n	Minimum	Maximum	Mean	SD
Age	300	18	89	53.34	16.53
Weight	300	50	90	67.75	7.36
DLP	300	159	1101.64	518.89	227.97
ED	300	2.22	15.41	7.33	3.26

The data were collected and analysed in both men and women separately. The mean age of male participants was 51.84 ± 16.87, with a minimum of 18 and a maximum of 83 years. The participants' average body weight was 67.47 ± 6.933 with a minimum of 50 and maximum of 86 kgs, as shown in Table 2.

Table 2: Male Statistics Summary

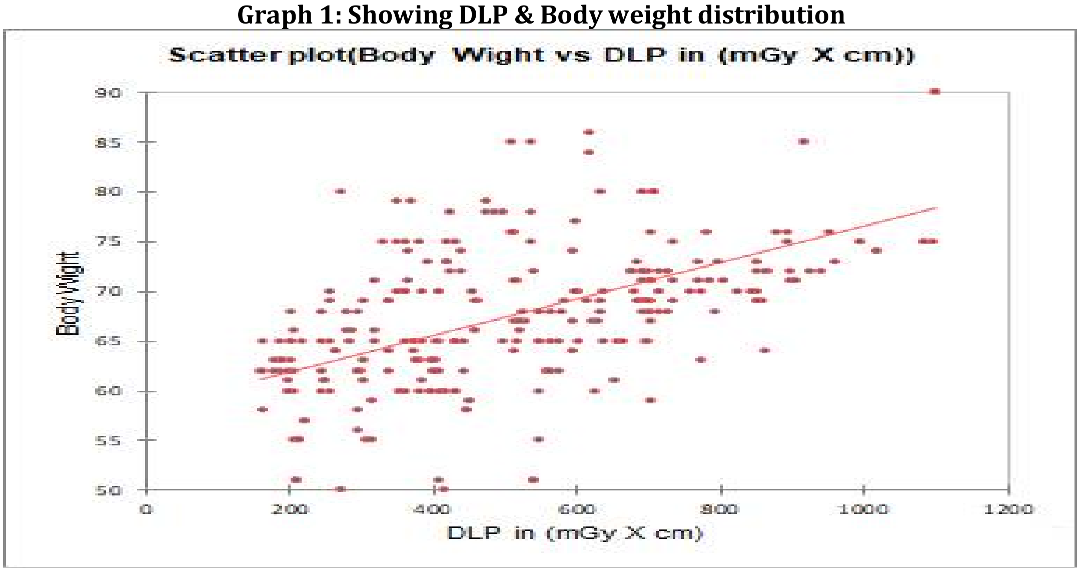
Variable	Observations	Minimum	Maximum	Mean	Std. deviation
DLP	181	159.000	1086.000	527.632	220.624
Body Wight	181	50.000	86.000	67.475	6.993

The mean age of female participants was 55.61 ± 15.82, with a minimum of 23 and a maximum of 89 years. The participants' average body weight was 68.17 ± 7.90, with a minimum of 51 and a maximum of 90 kgs, as shown in Table 3.

Table 3: Female Statistics Summary

Variable	Observations	Minimum	Maximum	Mean	Std. deviation
DLP	119	162.000	1101.640	505.604	239.057
Body Wight	119	51.000	90.000	68.168	7.896

Graph 1: Showing DLP & Body weight distribution



Data collected from 10 scanners showing the age and body weight of males and females with mean & SD separately are shown in Table 7. The data taken from different scanners shows variation when compared to each other. A positive correlation was found between DLP results and body weight across all scanners and both sexes, as shown in Table 5. This research also shows that sex and body weight significantly affect radiation doses, as shown in Table 6. The Dose length product provided by the scanners was higher in men than in women, irrespective of the scanner table 8. The study suggests that men receive more radiation doses than women on CT Chest examinations.

DISCUSSION

Three hundred (300) participants underwent a CT scan of the chest on ten (10) different MSCT scanners, with which each examination consisting of thirty patients. The included participants were selected to correspond to the typical participant (weight 45-90 kg). The DLP and effective dose were calculated in all participants. For chest protocol, the mean DLP in 300 participants was 518.89 ± 227.97 mGy X cm, and ED was 7.33 ± 3.26 mSv, as shown in Table 1.

Table 4: Data collected from 10 scanners showing the age of males and females with **mean & SD**

S.no	Scanner	Age		Mean ± SD	
		Male	Female	Male	Female
1	16 Slice GE Revolution	16	14	50.56 ± 11.97	52.64 ± 14.22
2	16 Slice Siemens Emotion	18	12	68.39 ± 12.77	65.33 ± 16.15
3	16 Slice Philips Brilliance	19	11	43.95 ± 17.97	54.82 ± 17.38
4	32 Slice Siemens Scope	20	10	46.30 ±16.66	52.10 ± 12.79
5	08 Slice GE Revolution ACTs	21	09	52.19 ± 13.79	54.44 ± 13.09
6	08 Slice Siemens Emotion	16	14	60.56 ± 16.00	66.86 ± 9.10
7	64 Slice Siemens Somatom	19	11	50.79 ± 17.70	55.64 ± 17.30
8	128 Slice Philips Ingenuity	19	11	51.43 ± 19.40	51.18 ± 15.74
9	64 Slice Toshiba Aquilion	18	12	45.67 ± 15.33	46.25 ± 12.09
10	64 Slice GE VCT	15	15	49.80 ± 13.74	54.67 ± 20.06

Data collected from ten different scanners were compared with each other, which shows that patients who undergo an examination on 64 Slice GE VCT slice receive the highest dose length product (DPL) while those patients who undergo an examination under 16 Slice Siemens Emotion slice receive the lowest dose length product (DPL) as shown in table 5.

Table 5: Showing combined DLP received by patients on different scanners during CT Chest examination.

S.no	Scanner	DLP		P-Value
		Mean	SD	
1	16 Slice GE Revolution	555.49	232.95	<0.001
2	16 Slice Siemens Emotion	309.60	138.95	
3	16 Slice Philips Brilliance	369.00	78.71	
4	32 Slice Siemens Scope	439.90	124.62	
5	08 Slice GE Revolution ACTs	627.69	259.23	
6	08 Slice Siemens Emotion	320.13	135.80	
7	64 Slice Siemens Somatom	499.50	294.84	
8	128 Slice Philips Ingenuity	696.40	103.72	
9	64 Slice Toshiba Aquilion	704.90	142.33	
10	64 Slice GE VCT	716.30	123.89	

Our study also suggests that generally, men receive the highest dose length product (DPL) than females despite of given weight. DLP had a more considerable unadjusted variance among heavier subjects, suggesting that the highest risk of overdosing occurred in that population. DLP was the highest for the 64 Slice GE VCT scanner, followed by the 64 Slice Toshiba Aquilion scanner. The mean DLP value was similar for the 16-slice Siemens Emotion and 08 Slice Siemens Emotion scanners, as shown in Table 5.

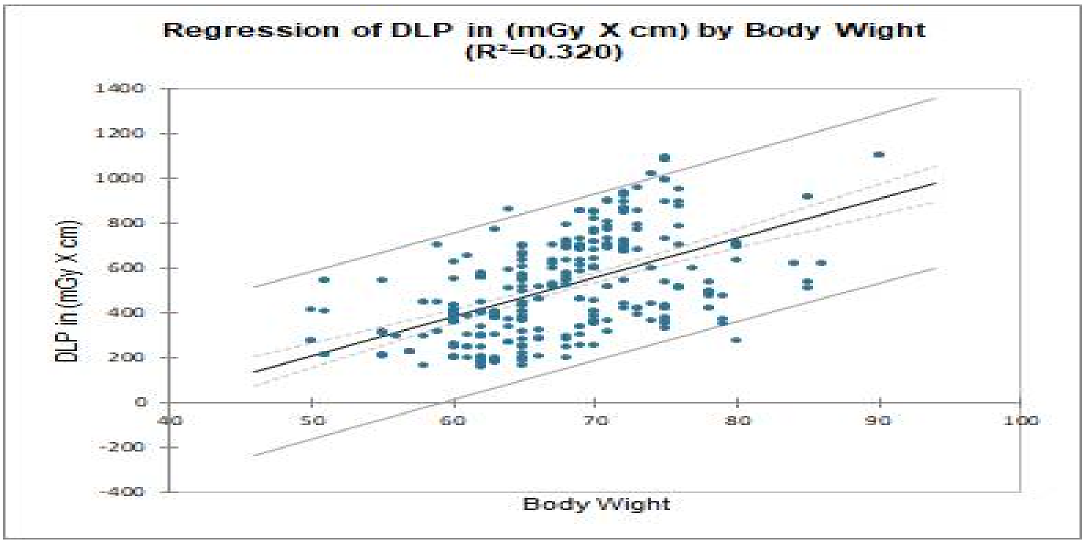
Table 6: Showing means effective doses received by male and female patients during CT Chest examination from each scanner.

S.no	Scanner	Effective Dose (mSv)				ED (mSv)
		Male		Female		All
		Mean	SD	Mean	SD	Mean ± SD
1	16 Slice GE Revolution	8.18	2.63	7.36	4.03	7.80 ± 3.32
2	16 Slice Siemens Emotion	4.54	2.02	4.00	1.86	4.33± 1.95
3	16 Slice Philips Brilliance	5.28	1.07	4.80	1.20	5.09 ± 1.13
4	32 Slice Siemens Scope	6.22	1.64	5.82	2.11	6.09 ± 1.78
5	08 Slice GE Revolution ACTs	8.56	3.67	9.53	3.65	8.85 ± 3.63
6	08 Slice Siemens Emotion	4.86	2.01	4.05	1.74	4.48 ± 1.90
7	64 Slice Siemens Somatom	7.69	4.55	5.97	3.46	7.04 ± 4.19
8	128 Slice Philips Ingenuity	9.65	1.58	10.05	1.37	9.65 ± 1.51
9	64 Slice Toshiba Aquilion	10.49	2.08	8.90	1.43	9.86 ± 1.98
10	64 Slice GE VCT	9.91	1.52	10.15	1.97	10.03 ± 1.73

Table 6 presented typical practical dose values for each scanner separately for male and female participants. The effective Dose was high in males than females except for 64 Slice GE VCT, 128 Slice Philips Ingenuity, and 08 Slice GE Revolution ACTs scanners.

Table 7: Showing means body weight of male and female patients involved in this study from each scanner.

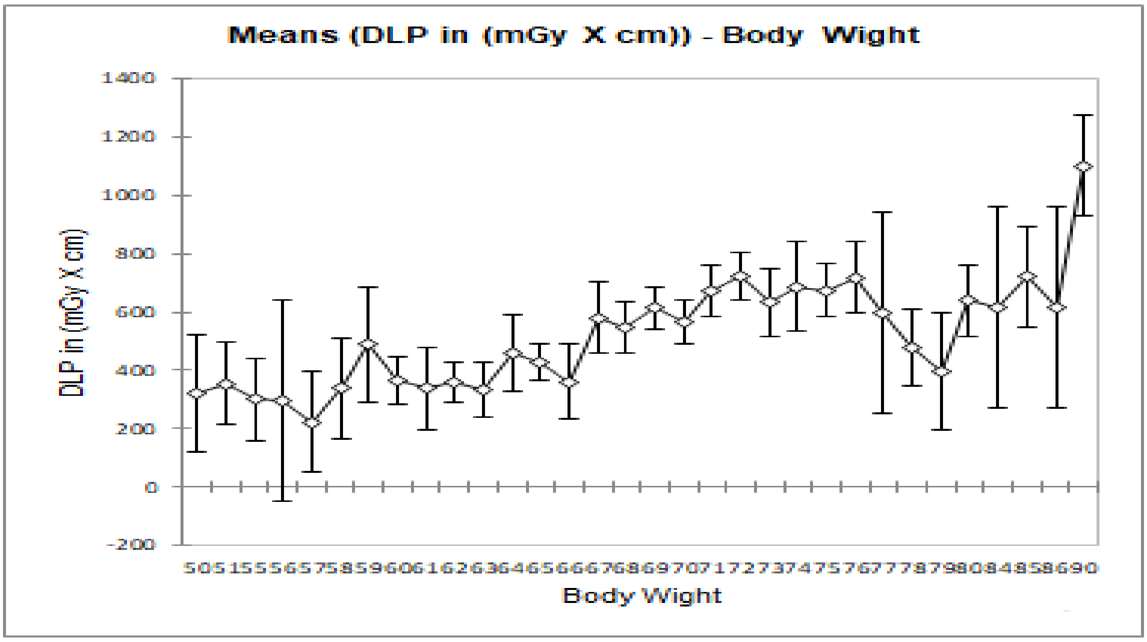
S.no	Scanner	Body Weight (kg)			
		Male		Female	
		Mean	SD	Mean	SD
1	16 Slice GE Revolution	69.25	7.87	70.79	11.01
2	16 Slice Siemens Emotion	69.83	8.18	67.67	6.27
3	16 Slice Philips Brilliance	63.32	7.19	63.91	1.20
4	32 Slice Siemens Scope	66.75	4.76	63.70	5.26
5	08 Slice GE Revolution ACTs	68.76	8.34	75.33	11.74
6	08 Slice Siemens Emotion	70.00	6.90	68.86	7.27
7	64 Slice Siemens Somatom	63.63	9.59	62.82	8.60
8	128 Slice Philips Ingenuity	67.03	3.73	68.73	6.51
9	64 Slice Toshiba Aquilion	69.44	2.50	68.42	1.88
10	64 Slice GE VCT	68.80	3.95	70.60	3.96



Graph 2: Comparing Body weight with DLP for CT Chest in all 10 scanners

Table 8: Showing DLP received by male and female patients during CT Chest examination.

	DPL (mGy x cm)				
	Male		Female		All
	Mean	SD	Mean	SD	Mean ±SD
16 Slice GE Revolution	579.36	181.11	528.21	285.83	555.49 ± 232.95
16 Slice Siemens Emotion	324.39	144.52	287.42	133.14	309.60 ± 138.95
16 Slice Philips Brilliance	378.53	74.96	352.55	85.91	369.00 ± 78.71
32 Slice Siemens Scope	446.60	115.24	426.50	147.33	439.90 ± 124.62
08 Slice GE Revolution ACTs	607.56+	259.25	674.66	268.39	627.69± 259.23
08 Slice Siemens Emotion	347.25	143.50	289.14	124.25	320.13 ± 135.80
64 Slice Siemens Somatom	541.9+5	317.55	426.18	247.49	499.50 ± 294.84
128 Slice Philips Ingenuity	696.40	106.27	720.05	99.32	696.40 ± 103.72
64 Slice Toshiba Aquilion	750.78	149.19	636.08	101	704.90 ± 142.33
64 Slice GE VCT	707.80	108.77	724.80	140.75	716.30 ± 123.89



Graph 3: Showing Means (DLP in (mGy X cm)) - Body Wight

Table 9: Comparison of CTDI, DLP, and ED of CT Chest in different countries

	TUTH	Taiwan [29]	Italy [30]	Wales [31]	Poland [26]	Tanzania [32]	Ireland [33]	Berlin [34]	UK [26]
CTDI (mGy)									
Chest	-	20	19.7	17	21.3	17	18.5	17.41	6.4
DLP (mGy x cm)									
Chest	523.89	455	473	663	447	783	434	502	203
Effective Dose (mSv)									
Cheat	7.3	8.4	8.0	-	-	13	7.6	-	-

Ed. Cambridge University Press, 2002.

Plots showing how DLP and body weight are related. The DLP is typically used to calculate overall radiation exposure for a particular CT scan. Ten scanners were utilised in the current study to investigate the role of gender and body weight in DLP-based radiation dose monitoring. Image quality was not compared between scanners, and imaging settings for each scanner were selected empirically. When using different imaging procedures and scanners, the dependence on sex, weight, and DLP levels varied. It should be emphasised that the produced DLP values rely on the parameters and do not represent how well the scanner performed. Three hundred patients underwent CT scans of chest examination for 10 different MSCT scanners, each MSCT Scanner examination consisting of 30 patients. The patients included were selected to correspond to the typical patient (weight 45-90 kg). The DLP and effective dose were calculated in the patient. For chest protocol, the mean DLP after the scan and ED were 555.49 ± 232.95 mGy-cm and 7.80 ± 3.32 mSv for 16 Slice GE Revolution, 309.60 ± 138.95 and 4.33± 1.95 for 16 Slice Siemens Emotion, 369.00 ± 78.71 and 5.09 ± 1.13 for 16 Slice Philips Brilliance, 439.90 ± 124.62 and 6.09 ± 1.78 for 32 Slice Siemens Scope, 627.69 ± 259.23 and 8.85 ± 3.63 for 08 Slice GE Revolution ACTs, 320.13 ± 135.80 and 4.48 ± 1.90 for 08 Slice Siemens Emotion, 499.50 ± 294.84 and 7.04 ± 4.19 for 64 Slice Siemens Somatom, 696.40 ± 103.72 and 9.65 ± 1.51 for 128 Slice Philips Ingenuity, 704.90 ± 142.33 and 9.86 ± 1.98 for 64 Slice Toshiba Aquilion, 716.30 ± 123.89 and 10.03 ± 1.73 for 64 Slice GE VCT as shown in table 5 and 6.

Table 10: Scan parameters and dose estimates for all scanners in Chest Examination

Scanner	n	kVp (n)	mAs [median (range)]	Pitch [median (range)]	Slice Thickness (mm)	DFOV (cm)	DLP [(mGy X cm) Mean]	ED [(mSv) Mean]	
								Male	Female
16 Slice GE Revolution	30	120,180	130,200	1.00 (0.8-1.8)	5	38	555.49	8.18	7.36
16 Slice Siemens Emotion	30	120,180	100,180	1.2 (0.8-1.8)	5	38	309.60	4.54	4.00
16 Slice Philips Brilliance	30	120,180	100,180	1.2 (0.8-1.8)	5	38	369.00	5.28	4.80
32 Slice Siemens Scope	30	120,180	120,180	1.2 (0.8-1.8)	5	38	439.90	6.22	5.82
08 Slice GE Revolution ACTs	30	120,180	130,200	1.00 (0.8-1.8)	5	38	627.69	8.56	9.53
08 Slice Siemens Emotion	30	120,180	100,180	1.2 (0.8-1.8)	5	38	320.13	4.86	4.05
64 Slice Siemens Somatom	30	120,180	130,200	1.2 (0.8-1.8)	5	38	499.50	7.69	5.97
128 Slice Philips Ingenuity	30	120,180	130,200	1.00 (0.8-1.8)	5	38	696.40	9.65	10.05
64 Slice Toshiba Aquilion	30	120,180	130,200	1.00 (0.8-1.8)	5	38	704.90	10.49	8.90
64 Slice GE VCT	30	120,180	130,200	1.00 (0.8-1.8)	5	38	716.30	9.91	10.15

During this study, the weight of all patients was recorded separately for each scanner for both gender patients, as shown in Table 6. In this study, the Body weight was compared with DLP for CT Chest examinations in all 10 scanners, as shown in Graph 1. DLP values were found to be sensitive to the subject's sex and weight in varying ways, with the degree of sensitivity varying among imaging techniques and scanner types. The characteristics of an imaging procedure in terms of radiation dose can be recognised with the help of the plots exhibiting the relationship of DLP with sex and weight. It is suggested that every facility evaluate its imaging protocols using these graphs. In a large patient, the FOV is expanded following body height, and AEC elevates mAs with elevated in-plane diameter. Consequently, with the same scanner and imaging procedure, the DLP rises. The current investigation showed that the DLP was substantially connected with weight regardless of the scanner and sex and that the connection patterns varied among scanners, similar to a previous study [22]. Linear regression is simple and only takes a minimal number of data points, and it was utilised in the current investigation to weigh the DLP. For most assessments, patients self-reported their body weight, which may have reduced accuracy. Equations that are not linear might offer better adjustment. Inoue *et al.* (2015)[30] measure the DLP in Chest considering sex, age and DLP was found to be often employed in the study to calculate the radiation level in CT scans. Eight hundred (800) chest CT scans were collected and analysed for the study. Linear regression was used to examine a correlation between the DLP and BW (body weight) in both sexes. Computed tomography (CT) scanners varied in how much they relied on factors like patient sex and weight when determining radiation exposure. Scanners can be compared with one another regarding radiation dose by using standardised DLP values that account for differences in sex and body weight. Exams with potentially high radiation doses were identified after adjusting the Dose-length product (DLP) for sex (Gender) and weight (BW). Comparisons of dosage across imaging procedures, CT scanners, and daily observations tend to benefit from monitoring the dose length product (DLP) to sex (gender) and body weight (BW). Mastora et al. (2009) calculated the $CTDI_{VOL}$, DLP, and effective Dose at several body regions and compared the results to the EC[23] (regular chest, cervical spine, belly, and chest inspections). According to a CT survey, adults' typical DLP values varied from (923.2-1394.6) mGy-cm for the brain, (854.7-1517.8) mGy-cm for the neck, and (301.0-1029.1) mGy-cm for the chest (abdomen). The average effective dosages for the head, chest, cervical spine, and belly were 2.47, 7.53, 9.87, 6.20, 9.49, and 15.22 mSv.The values for the head, chest and abdomen checks were more significant than in this study. The effective Dose was quantified by Oberg et al., 2007 and used in medical practice. Specifically, they wanted to figure out the ED[24]. The results of this research have the potential to be utilised as the basis for standardised protocols relating to the exposure doses required for routine CT exams of the head, chest, and abdomen. A total of 426 CT scans on adults and 26 on children were measured for CTDI in the air by Abdullah et al. 2009 at Malaysian hospitals. Studies performed for European guidelines, the UK, and Taiwan showed a similar range of effective dosages for routine head, chest, and pelvic inspections. Compared to studies based on European guidelines and Taiwan, the effective doses for routine abdominal inspection were similar but 55.1% higher than the figure from the UK study. Third-quartile values of effective doses for all CT examinations collected were provided by the study to aid in defining the dosage reference level for CT examinations in Malaysia[25]. Results showed higher CTDI and DLP for CT scans of the brain, chest, and abdomen compared to the UK.

CTDI (air) was studied by Abdullah et al., 2009, in 426 adults and 26 paediatrics CT scans performed in Malaysian hospitals. It gave the third-quartile practical dose values for all of the CT exams gathered, which can be used to set the dosage reference level for CT exams in Malaysia26. Studies conducted for European guidelines, the United Kingdom, and Taiwan all found the same range of effective doses for routine head, chest, and pelvic examinations. Compared to European guidelines and Taiwan studies, the effective Dose for the regular abdominal check was still within the range, although it was 55.1% greater than the result from the UK trial. CTDI and DLP were more remarkable in this study than in the UK for all body locations scanned.

Elameen et al. (2010) examined radiation exposures from 160 CT scans at three hospitals in Sudan[28]. Based on the results of a CT survey, the average DLP for adult patients varied between 272 and 460 milligrams per cubic centimetre of the head, 195 and 995 milligrams per cubic centimetre of the chest, and 270 and 459 milligrays per cubic centimetre of the body (abdomen). By utilising CT dose indices, exposure data, and CTDI to practical dose conversion factors, we determined the effective dosage for each examination. The dose length product and CT air kerma index were lower than the internationally recognised threshold for safe radiation levels. Regarding organ doses, the average brain dose was 0.82 mSv, the average chest dose was 3.7 mSv, and the average abdominal Dose was 5.4 mSv. The average effective Dose in Sudan was lower than in other nations. The CTDI, DLP, and ED all varied.

The optimal dosage was calculated and used in medicine by Oberg et al., 2007. Their objective was to calculate the ED[27]. These statistics promise exposure doses for routine head, chest, and abdomen CT tests, which might be included in standard practice.

The $CTDI_{VOL}$, DLP, and effective dosage for the routine head, cervical spine, abdominal, and chest inspections were determined by Mastora et al. (2009) and compared to the EC[29]. Researchers found the results were higher for head and chest checks but lower for the abdomen. A CT study found that adult patients' average DLP for the chest, cervical spine, and abdomen was 2.47, 7.53/9.87, 6.20, and 9.49/15.22 mSv, respectively[29].

Table 11: Comparison of $CTDI_{VOL}$, DLP, ED of TUTH with European Commission (EC)

Examination		Mean (TUTH)	EC
Chest	$CTDI_{VOL}$ (mGy)	------	30
	DLP (mGy X cm)	523.89	650
	Eff. Dose (mSv)	7.32	11.1

CONCLUSIONS

This study's findings underscore the value of considering gender and body mass index while using DLP to track radiation exposure during Chest CT. The DLP was different for men and women and increased with size. The DLP's association with sex and body weight mirrors the characteristics of radiation exposure during the imaging procedure. The DLP can be more comparable between scanners and imaging modalities by controlling for patient sex and body mass index. The modification makes it easier to spot unforeseen shifts in radiation dose.

It was found that the DLP and ED for the standard chest procedure were far lower than the European Commission's (EC) recommendations. Despite the DLP and effective Dose of the Chest examination being less than the EC, the diagnostic image quality was not compromised.

REFERENCES

1. Kalra, M. K., Maher, M. M., Toth, T. L., Hamberg, L. M., Blake, M. A., Shepard J. A., et al. (2004). Strategies for CT radiation dose optimisation. Radiology, 230, 619-628. https://doi.org/10.1148/radiol.2303021896
2. Rehani, M. M., & Berry, M. (2000). Radiation doses in computed tomography. The increasing doses of radiation need to be controlled. BMJ, 320(7235), 593-594. https://doi.org/10.1136/bmj.320.7235.593
3. Prokop, M. (2003). Multidetector-row CT: Technical principles and future trends. European Radiology, 13(Suppl 5), M3-M13. https://doi.org/10.1007/s00330-003-1786-z
4. Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation, National Research Council. (2006). Health risks from exposure to low levels of ionizing radiation: BEIR VII Phase 2. National Academies Press. https://doi.org/10.17226/11340
5. Hall, E. J., & Brenner, D. J. (2008). Cancer risks from diagnostic radiology. British Journal of Radiology, 81(965), 362-378. https://doi.org/10.1259/bjr/01948454
6. Jangland, L., Sanner, E., & Persliden, J. (2004). Dose reduction in computed tomography by individualised scan protocols. Acta Radiologica, 45(3), 301-307. https://doi.org/10.1080/02841850410005625
7. International Atomic Energy Agency. (1996). International basic safety standards for protection against ionising radiation and the safety of radiation sources (IAEA Safety Series No. 115).
8. European Union. (1997). Council directive 97/43 Euratom of 30 June 1997 on health protection of individuals against the dangers of ionizing radiation in relation to medical exposure (Repealing Directive 84/466 Euratom).
9. Golding SJ, Shrimpton PC. Radiation dose in CT: are we meeting the challenge. The British Journal of Radiology 2002; 75:1–4.
10. Naik, K. S., Ness, L. M., Bowker, A. M. B., & Robinson, P. J. A. (1996). Is computed tomography of the body overused? An audit of 2068 attendances in a large acute hospital. British Journal of Radiology, 69(823), 126-131. https://doi.org/10.1259/0007-1285-69-823-126
11. European Communities. (1999). European guidelines on quality criteria for computed tomography.
12. Mathews, J. D., Forsythe, A. V., Brady, Z., Butler, M. W., Goergen, S. K., Byrnes, G. B., Giles, G. G., Wallace, A. B., Anderson, P. R., Guiver, T. A., McGale, P., Cain, T. M., Dowty, J. G., Bickerstaffe, A. C., & Darby, S. C. (2013). Cancer risk in 680 000 people exposed to computed tomography scans in childhood or adolescence: data linkage study of 11 million Australians. BMJ, 346, f2360. https://doi.org/10.1136/bmj.f2360
13. Pearce, M. S., Salotti, J. A., Little, M. P., McHugh, K., Lee, C., Kim, K. P., Howe, N. L., Ronckers, C. M., Rajaraman, P., Sir Craft, A. W., Parker, L., & Berrington de González, A. (2012). Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: A retrospective cohort study. The Lancet, 380(9840), 499–505. https://doi.org/10.1016/S0140-6736(12)60815-0
14. Brenner, D. J., & Hall, E. J. (2007). Computed tomography—An increasing source of radiation exposure. New England Journal of Medicine, 357(22), 2277–2284. https://doi.org/10.1056/NEJMra072149
15. Goo, H. W. (2012). CT radiation dose optimization and estimation: An update for radiologists. Korean Journal of Radiology, 13(1), 1–11. https://doi.org/10.3348/kjr.2012.13.1.1
16. Lee, T. Y., & Chhem, R. K. (2010). Impact of new technologies on dose reduction in CT. European Journal of Radiology, 76(1), 28–35. https://doi.org/10.1016/j.ejrad.2010.06.031
17. Duong, P. A., & Little, B. P. (2014). Dose tracking and dose auditing in a comprehensive computed tomography dose reduction program. Seminars in Ultrasound, CT and MRI, 35(4), 322–330. https://doi.org/10.1053/j.sult.2014.05.002
18. Midgley, S. M. (2014). Capture and analysis of radiation dose reports for radiology. Australasian Physical & Engineering Sciences in Medicine, 37(4), 805–819. https://doi.org/10.1007/s13246-014-0296-5
19. Lee, C. H., Goo, J. M., Ye, H. J., Ye, S. J., Park, C. M., Chun, E. J., & Im, J. G. (2008). Radiation dose modulation techniques in the multidetector CT era: from basics to practice. Radiographics, 28(5), 1451–1459. https://doi.org/10.1148/rg.285075702
20. Kalra, M. K., Maher, M. M., Toth, T. L., Schmidt, B., Westerman, B. L., Morgan, H. T., & Saini, S. (2004). Techniques and applications of automatic tube current modulation for CT. Radiology, 233(3), 649–657. https://doi.org/10.1148/radiol.2333031150
21. Iball, G. R., & Tout, D. (2014). Computed tomography automatic exposure control techniques in 18F-FDG oncology PET-CT scanning. Nuclear Medicine Communications, 35(4), 372–381. https://doi.org/10.1097/MNM.0000000000000062
22. Iball, G. R., & Tout, D. (2014). Computed tomography automatic exposure control techniques in 18F-FDG oncology PET-CT scanning. Nuclear Medicine Communications, 35(4), 372–381. https://doi.org/10.1097/MNM.0000000000000062
23. Mastora, S. (2009). Patient dose in common CT (Master's thesis, University of Patras, Greece).
24. Oberg, M. (2011). Patients doses for CT examinations in Denmark (Master's thesis, Technical University of Denmark, Denmark).
25. Abdullah, A. (2009). Establishing dose reference level for computed tomography (CT) examinations in Malaysia (Master's thesis, Universiti Sains Malaysia, Malaysia).
26. Abdullah, A. (2009). Establishing dose reference level for computed tomography (CT) examinations in Malaysia (Master's thesis, Universiti Sains Malaysia, Malaysia).
27. Oberg, M. (2011). Patients doses for CT examinations in Denmark (Master's thesis, Technical University of Denmark, Denmark).

28. Elameen, S. (2010). Technique and radiation dose in CT examination of adult patients (Master's thesis, Sudan Academy of Sciences (SAS) Atomic Energy Council).
29. Mastora, S. (2009). Patient dose in common CT (Master's thesis, University of Patras, Greece).
30. Inoue, Y., Nagahara, K., Hayakawa, N., Hanawa, H., & Hata, H. (2016). Monitoring dose–length product in computed tomography of the chest considering sex and body weight. Radiation Protection Dosimetry, 171(3), 375–381. https://doi.org/10.1093/rpd/ncv401

CITATION OF THIS ARTICLE

Maajid Mohi Ud Din Malik. Estimation of dose length product (DLP) using MSCT for CT Chest based on sex and body weight in north India. Bull. Env.Pharmacol. Life Sci., Vol 13 [1] December 2023: 256-265