CTDI offered a more convenient yet nominally equivalent method of estimating this value, and required only a single-scan acquisition, which in the early days of CT, saved a considerable amount of time [7-8].

$CTDI_{100}$ represents the accumulated multiple scan dose at the center of a 100-mm scan and underestimates the accumulated dose for longer scan lengths. It is thus smaller than the equilibrium dose or the MSAD. In the case of $CTDI_{100}$, the integration limits are ±50 mm, which corresponds to the 100mm length of the commercially available "pencil" ionization chamber [17]. On the assumption that dose in a particular phantom decreases linearly with radial position from the surface to the centre, then the normalized average dose to the slice is approximated by the (normalized) weighted CTDI: [mGy(mAs)$^{-1}$]

$$nCDTI_W = \frac{1}{C}\left(\frac{1}{3}CDTI_{100,\,C} + \frac{2}{3}CDTI_{100,\,P}\right) \qquad (3)$$

Where:

- C is the tube current x the exposure time (mAs)
- $CTDI_{100,\,p}$ represents an average of measurements at four different locations around the periphery of the phantom [9-10]

Volume $CDTI_{vol}$ represent dose for a specific scan protocol, which almost always involves a series of scans, it is essential to take into account any gaps or overlaps between the x-ray beams from consecutive rotations of the x-ray source. This is accomplished with use of a dose descriptor known as the Volume $CTDI_w$ ($CTDI_{vol}$), where

$$CDTI_{vol} = \frac{N \times T}{I} \times CDTI_w \qquad (4)$$

Where I= the table increment per axial scan (mm). Since pitch is defined as the ratio of the table travel per rotation (I) to the total nominal beam width (NxT).

$$Pitch = I / (NxT) \qquad (5)$$

Thus, Volume CTDI can be expressed as;

$$CTDI_{vol} = 1 / pitch \times CTDI_w \qquad (6)$$

While $CTDI_{vol}$ estimates the average radiation dose within the irradiated volume for an object of similar attenuation to the CTDI phantom, it does not represent the average dose for objects of substantially different size, shape, or attenuation or when the 100-mm integration limits omit a considerable fraction of the scatter tails [3].The Dose Length Product (DLP) is also calculated by the scanner. DLP is the product of the length of the irradiated scan volume and the average $CTDI_{vol}$ over that distance. DLP has units of mGy*cm [11].

$$DLP\ (mGy\text{-}cm) = CTDI_{vol}\ (mGy) \times scan\ length\ (cm) \qquad (7)$$

The DLP reflects the total energy absorbed (and thus the potential biological effect) attributable to the complete scan acquisition. Thus, an abdomen-only CT exam might have the same $CTDI_{vol}$ as an abdomen/pelvis CT exam, but the latter exam would have a greater DLP, proportional to the greater z-extent of the scan volume [12].

2. Materials and Methods

The data used in this study were collected from Department of Radiology, Department A (Elnileen Medical Diagnostic Centre- Khartoum) and Department B (Antalya Medical Center Department of Diagnostic Radiology – Khartoum). A total of 37 patients were evaluated. The age of all patients who were admitted in this study between 14–80 years. For each patient the following data were recorded patient demographic data, exposure factors, and scan parameters were recorded. For each patient, the following data were recorded (age, gender, weight and height) as well as the following scan parameters (kVp, mAs, slice thickness, number of slices, rotation time, displayed CTDIvol and displayed DLP). Ethics and research committees at all hospitals approved the study and informed consent was obtained from all patients prior to the procedure. The patient dose estimation from CT examination using the Monte Carlo technique requires measurements of CTDI and conversion coefficient data packages. Due to the fact that the software does not take into account the patient size, that is, the software was not discriminate between tall and short patients, it was necessary to adjust the scan region indicated on the human skeleton from each patient survey form in NRPB's mathematical phantom for each individual examination [14]. Modern CT systems display the $CTDI_{vol}$ and DLP information for every scan acquisition.Patient dose, particularly equivalent doses in the patients' organs, can be used for assessment of the associated carcinogenic risk of radiation. Effective dose is often used as an expression of population patient risk; however it is correctly applicable only for limited conditions. Although effective dose calculations require specific knowledge about individual scanner characteristics, a reasonable estimate of effective dose, independent of scanner type, can be achieved using the relationship:

$$Effective\ Dose = E_{DLP} \times DLP \qquad (8)$$

Where E_{DLP} is a weighting factor (mSv ×mGy^{-1}×cm^{-1}) which depends only upon body regions.

3. The Results

This study involved 37 CT patients undergoing abdomen examinations in Department of Radiology, Department A (Elnileen Medical Diagnostic Centre, Khartoum) and Department B (Antalya Medical Center Department of Diagnostic Radiology, Khartoum). The results were tabulated in the Tables (mean ± standard deviation (SD)) and the range of the readings in parenthesis. The dose values in diagnostic radiology are small, therefore the dose were presented in (mSv). The mean and the standard deviation were calculated using the excel software. For dose calculation, patient individual exposure parameters were recorded (tube voltage (kV), tube current and exposure time product (mAs) and Focus to skin distance (FSD), CTDI volume, DLP dose (mGy.cm). Patient demographic data (age, height, weight, BMI) were presented per department. Patients' ESD were measured in two CT departments equipped with two different

CT imaging machines. Figures (1-9) showed the results of the measured.

Department A:

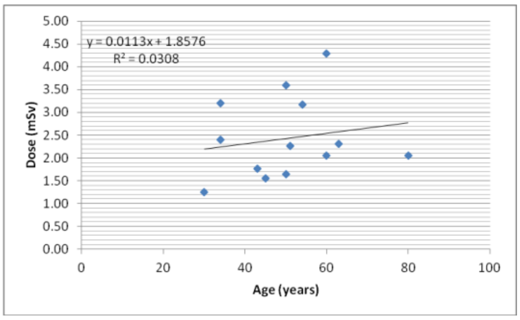

Figure 1: Correlation between Age and dose

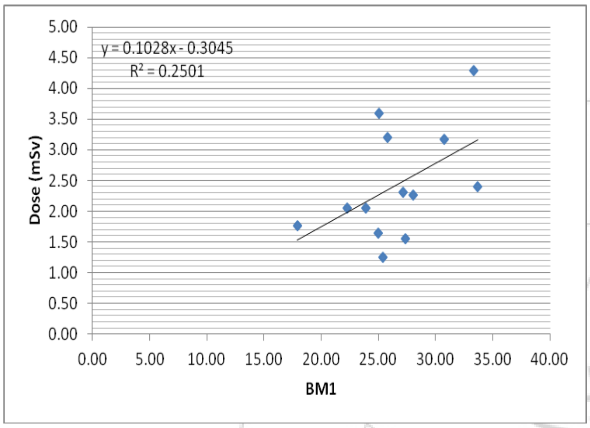

Figure 2: Correlation between Body Mass Index(BMI) and dose

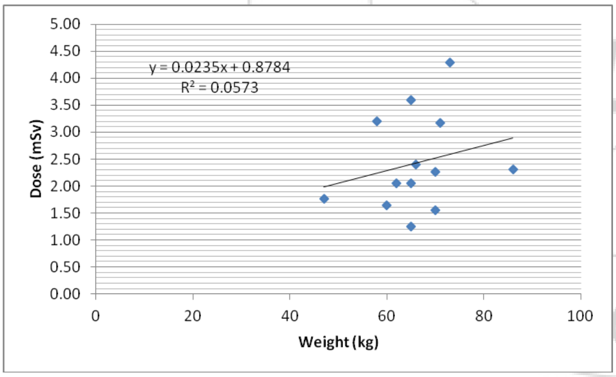

Figure 3: Correlation between body weight and dose

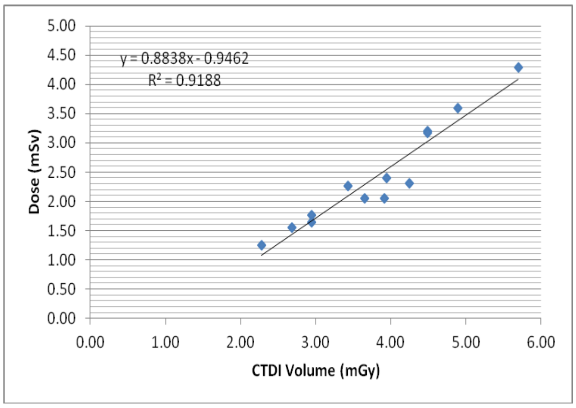

Figure 4: Correlation between CTDI volume and dose

Department B:

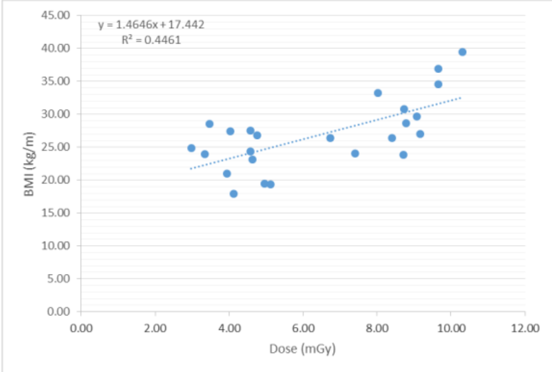

Figure 5: Correlation between Body Mass Index and dose

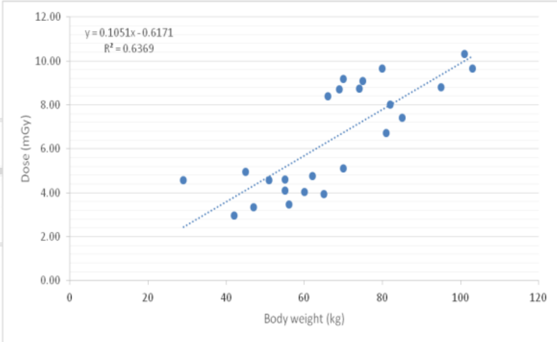

Figure 6: Correlation between body weight and dose

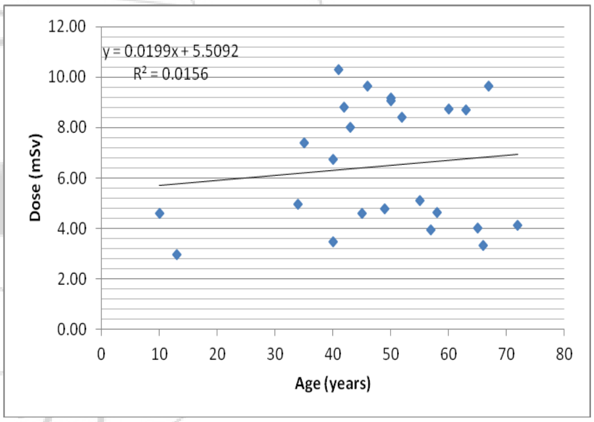

Figure 7: Correlation between Age (years) and dose

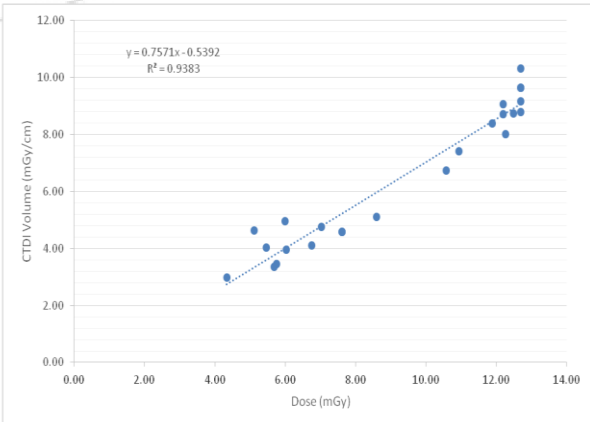

Figure 8: Correlation between CTDI volume and dose

Table 1. shows the mean and standard deviation of effective dose is used for CT abdomen examination in the study sample from Hospital (A) and Hospital (B)

Deparment	Hospital "A"	Hospital "B"
Effective Dose (mSv)	2.43 $\pm$ 0.85	6.57 $\pm$ 2.38

4. Conclusion

In this paper, we have described a common sense approach to more efficient radiation dose management for body CT. It is not possible to provide recipes or "one size fits all" protocols for body CT because of differences in patient body habitus, clinical indications, and CT scanner capabilities. Understanding the interrelationships between CT technical factors, image quality, and radiation dose is essential. Doses for standard-sized patients are within national DRLs. Doses for all patient sizes on GE scanner are ~25% higher than on Siemens Doses for large patients are up to 3x higher on GE scanner compared to Siemens scanner. Noise values on Siemens scanner increase with patient size but on GE scanner there was no correlation between noise and patient size. In current literature, numerous differing recommendations can be found on how to reduce (mAs) settings with patient weight or diameter.

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Author Profile

Yousif Mohamed Yousif Abdallah received the B.S., M.Sc. and PhD degrees nuclear medicine and Radiation Therapy from College of Medical radiological Science, Sudan University of Science and Technology in 2005, 2009 and 2013 respectively. He was professor (assistant) in College of Medical radiological Science, Sudan University of Science and Technology from September 2006 to March 2015. Form March 2015 till now, he is now Professor (assistant) in department of Radiological Sciences and medical Imaging, College of Medical Applied Sciences, Majmaah University, Majmaah, Saudi Arabia.

Magbool A. H. Salih received the B.Sc. and M.Sc. in Medical Physics in Medical Science Academy. He is now lecturer in Blue Nile State Branch Eldamasain, Blue Nile State, Sudan.