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Assessment of Dose and Lifetime Risk of Exposure Induced Cancer in Adult Common Computed Tomography Scans in Douala-Cameroon

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Abstract

Background: Among medical technologies that use ionizing radiation, CT is currently the radio diagnostic technic that can deliver the highest radiation to the Patient compared with other conventional procedures. In developing countries, the uses and risks of CT have not been well characterized. **Objective:** To estimate the lifetime attributable risk (LAR) incidence and mortality for cancer for each procedure for adult's patients who had Computed Tomography examinations in 10 imaging centers in the city of Douala-Cameroon so as to provide a reference data. **Materials and Methods:** We conducted a cross-sectional study describing radiation dose associated with the 8 most common types of diagnostic CT studies performed on 1287 consecutive adult patients at 10 Douala radiology department. We estimated lifetime attributable risks of cancer by study type from these measured doses. Estimation of LAR for cancer incidence and mortality was based on the effective dose, patient's sex and age at exposure using the BIER VII preferred models. **Results:** Mean effective dose from CT scans examinations varied from: 0.30 and 8.81 mSv. The highest doses were observed for lumbar spine CT (8.81 mSv), followed by abdomen-pelvis procedure (6.46 mSv), chest-abdomen-pelvic CT (6.61 mSv), chest CT (3.90 mSv), cervical Spine CT (3.05 mSv), head CT (1.7 mSv) and lower for sinus CT (0.30 mSv). The LAR values of all cancer from patients' CT scans obtained vary from 67.13 excess per 100,000 (about 1 in 1489) and 0.45 excess per 100,000 (about 1 in 222,222). All cancer risk was high for lumbar spine CT in women 20 years old (67.13 excess deaths in

100,000 scans) followed by chest-abdomen-pelvic CT (50.36 excess deaths in 100,000 scans) and abdomen-pelvic CT (49.22 excess deaths in 100,000 scans) for the same age group. The LAR of incidence and mortality values were higher from female's patients than males and higher for younger than older patients. **Conclusion:** This study was set out to estimate the LAR values associated with adult common CT scans procedures. The data indicates, LAR risks related to induced cancer from CT exposures were estimated to be low. This risk can be relatively significant for younger age group compared to older age group. The LAR values obtained will help to better evaluate radiation exposure risk, before ordering a CT scans examinations.

Keywords

Patient Dose, CT Scan, BEIIR VII Report, Cancer Risk Assessment

1. Introduction

In addition to natural background radiation, people are also exposed to low- and high-LET radiation from man-made sources such as X-ray equipment and radioactive materials used in medicine, research, and industry. Medical irradiation represents the first source of radiation exposure of artificial origin [1]. Computed tomography (CT) is a method that extends the clinical capabilities of X-ray imaging. The use of CT scans in adults experiencing symptoms of illness or injury is widely accepted, and CT scan use has increased substantially in the last several decades [2].

While this technique provides valuable diagnostic information, its high contrast sensitivity visualizes soft tissues and produces tomographic (slice) and three-dimensional (3D) volumetric images. CT is one of the most critical tools used for diagnosis, it has a downside which is the increased exposure of patients to ionizing radiation [3]. It represents only 5% of radiological procedures but 34% of collective irradiation [4].

CT examinations result in higher organ doses of radiation than conventional single-film X-rays. This is because CT scanners rotate around the body, taking a series of cross-sectional X-rays. A computer compiles these X-ray slices to produce a three-dimensional portrait. According to Brenner and Elliston, who estimated both radiation dose and risks from such procedures, a single full-body scan results in a mean effective radiation dose of 12 mSv [5]. These authors write, "To put this (dose) in perspective, a typical mammogram ... has an effective dose of 0.13 mSv—a factor of almost 100 times less." According to Brenner and Elliston's calculations, "a 45-year-old adult who plans to undergo 30 annual full-body CT examinations would potentially accrue an estimated lifetime cancer mortality risk of 1.9% (almost 1 in 50). Correspondingly, a 60-year-old who plans to undergo 15 annual full-body CT examinations would potentially accrue an estimated lifetime cancer mortality risk of one in 220" [5].

Although the long-term effects of low doses of ionizing radiation are still very controversial [6] [7]. An important task of the BEIR VII committee was to develop "risk models" for estimating the relationship between exposure to low levels of low-LET ionizing radiation and harmful health effects. The committee judged that the linear no-threshold model (LNT) provided the most reasonable description of the relation between low-dose exposure to ionizing radiation and the incidence of solid cancers that are induced by ionizing radiation [2].

This study aimed to assess the lifetime attributable risk (LAR) incidence and mortality for cancer for adult patients undergoing common computed tomography examinations performed in radiology department in the city of Douala-Cameroun.

2. Materials and Methods

2.1. Study Design and Participating Services

This retrospective review of the adult CT scans that were conducted in 10 radiology departments in the city of Douala-Cameroon. Exams were randomly selected within age-gender-year strata from April 2019 and April 2020.

2.2. Data Collection

A total of 1287 adult patients aged > 20 years, underwent CT examinations and may provide appropriate DLP data according to body region were included in this study, 628 females (48.8 %) and 659 males (51.2%). Study describing radiation dose associated with the 8 most common CT examination protocol of abdomen/pelvis, head, cervical spine, petrous bone, sinus, lumbar spine, chest/abdomen/pelvis and chest were collected.

Patient scan details had been previously recorded in the service CT logbook. The following data were collected: For each CT machine: brand, model and detector rows. For each CT performed: Patient's age and gender, types of CT examinations and date of completion of the examination. The technical exposure parameters and delivered doses including: number of acquisitions, console-displayed Dose Length Product values (DLP) in mGy·cm (milliGray.centimeter) for each acquisition and the complete DLP of the examination were collected from the picture archiving and communiction system (PACS) for each patient. Other studied variables were: Used of IV contrast (IV−/IV+).

2.3. Dose Calculation

For each patient, the average DLP value for exam was calculated and the average Effective dose was calculated by conversion factors retrieeved from Shrimpton study [8]. from the International Commission on Radiological Protection (ICRP) [9] [10]. and from the American Association of Physicists in Medecine (AAPM) Task Group 23 [11] (reported in **Table 1**). The average Effective Dose (ED) doses associated with the CT-exams studied were assessed from the calculated DLP using a region- and age-specific coefficient:

$$E(\text{mSv}) = \text{EDLP}_{\text{region,age}} \times \text{DLP} \quad (1)$$

where $\text{EDLP}_{\text{region,age}}$ (mSv (mGy·cm)$^{-1}$) is the normalized value of effective dose per dose-length product over a specific body region for a particular standard patient age [12]-[14].

Table 1. The conversion factors used for the calculation of effective dose from DLP, retrieved from AAPM TG 23 [12] and ICRP 103.

Anatomical Region	EDLP (mSv.mGy^{-1}cm^{-1}) AAPM TG 23	EDLP (mSv.mGy^{-1}cm^{-1}) ICRP 103
Head	**0.0021**	**0.0019**
Neck	**0.0058**	**0.0052**
Head + Neck	**0.0031**	**-**
Chest	**0.0148**	**0.015**
Abdomen + Pelvis	**0.0154**	**0.014**
Trunk	**0.015**	**0.014**

2.4. Cancer Risk Evaluation

The overall lifetime attributable cancer risk (LAR) for cancer incidence and mortality was estimated for each patient, based on the effective dose, patient's sex and age at exposure using the BIER VII preferred models [15]. This was estimated from tables 12D-1 and 12D-2, respectively, documented in the BEIR VII report schow lifetime risk estamates for cancer incidence and mortality resulting from a single dose of 0.1 Gy at several specific ages. Estimates are shown for, all cancer, leukemia, all solid cancer, and cancer of several specific sites [5] (displayed as **Table 2** and **Table 3** in this study). These values present the additional risk of different cancers and the total risk of all cancers for ages ranging from 0 to 80 years in both sexes for a dose of 0.1 Gy per 100,000 individuals.

Table 2. LAR, lifetime attributable risk of cancer incidence, Table 12D-1 BEIR VII Phase 2.

Cancer site	gender	Age at Exposure (years)										
		0	5	10	15	20	30	40	50	60	70	80
All cancers	F	4777	3377	2611	2064	1646	1065	886	740	586	409	214
	M	2563	1816	1445	1182	977	686	648	591	489	343	174

Note: Number of cases per 100,000 persons exposed to a single dose of 0.1 Gy.

Table 3. Lifetime attributable risk of cancer mortality, Table 12D-1 BEIR VII Phase 2.

Cancer site	gender	Age at Exposure (years)										
		0	5	10	15	20	30	40	50	60	70	80
All cancers	F	1770	1347	1104	914	762	542	507	469	409	317	190
	M	1099	852	712	603	511	381	377	360	319	250	153

Note: Number of deaths per 100,000 persons exposed to a single dose of 0.1 Gy.

$$\text{LAR}_{\text{at age of exposure}} = \frac{\text{Effective dose}(\text{Sv})}{0.1} \times \frac{\text{LAR}_{(\text{cancer incidence})\text{at age of exposure}}}{100000} \quad (2)$$

$$\text{LAR}_{\text{at age of exposure}} = \frac{\text{Effective dose}(\text{Sv})}{0.1} \times \frac{\text{LAR}_{(\text{cancer mortality})\text{at age of exposure}}}{100000} \quad (3)$$

2.5. Statistical Analysis

Data were recorded in a excel spreadsheet (v. 2016, Microsoft). The data collection represented a non-random sampling of all the records gathered over a designed period. The dose metrics were analyzed. We provided the mean of DLPs and Eds that were calculated for each age group and projected lifetime attributable cancer risks.

2.6. Ethical Considerations

This study was authorized by the Institutional Research Ethics Committee for Human Health at the University of Douala and by the Regional Health Delegation of the littoral Region of Cameroon. In order to respect confidentiality, all the data collected was studied anonymously, the services were coded by numbers (from 1 to 10).

3. Results

3.1. Participating Services and Characteristics of CT Machine

The number of services participants in the study, brand characteristics of the CT machines are presented in Table 4.

Table 4. Characteristics of the involved CT scanners.

Site	Characteristics of CT Machine			
	CT Machine	Manufacturer	Model	Detector Rows
01	A	Hitachi	SCENARIA	64
02	B	Hitachi	SUPRIA	16
03	C	Hitachi	ECLOS	16
04	D	General Electric	REVOLUTION	16
05	E	Toshiba	ASTEION	08
06	F	General Electric	HISPEED DUAL	02
	G	Hitachi	SUPRIA	16
07	H	General Electric	HISPEED	02
08	I	General Electric	PROSPEED II	02
09	J	General Electric	BRIGHTSPEED	16
10	K	Hitachi	ECLOS	16

3.2. Patients Characteristics

The characteristic of patients include number, age and genders are shown in Table 5. A total of 1278 patients undergoing CT examinations of abdomen/pelvis, head, cervical spine, petrous bone, sinus, lumbar spine, chest/abdomen/pelvis and chest performed. In this study CT examinations were equally performed among male (659/1287, 51.2%) and female (719/1287, 48.8%) patients.

Table 5. Distribution of patients according to age and sex.

Age range	Number		Total	Percentage	
	Male	Female		Male	Female
Adult (>15 years old)	659	628	1287	51.2	48.8

3.3. Radiation Dose

Table 6. Dosimetry data according to the type of CT-scan exam: median, mean, and 75th percentile of PDL distributions and mean of the effective dose values per CT-scan exam.

CT Procedures	Number per gender		Total number	DLP (mGy.cm)			E (mSv) according to EDLP/ICRP 103
	M	F		**median**	**mean**	**75^e percentile**	
Abdomen-pelvic	87	94	181	372.2	462.65	715.20	6.46
Head/+IV	120	81	183	785.5	908.80	1289.20	1.7
Head/−IV	85	98	201	763.5	737.46	964.55	1.4
Cervical spine	78	62	140	584.5	587.73	852.55	3.05
Lumbar spine	83	97	180	649.4	629.70	976.10	8.81
Petrous bone	1	1	2	1064.9	984.50	1100.90	1.86
Sinus	36	44	80	128.52	160.33	152.25	0.30
Chest, abdomen and pelvic	81	79	160	340.45	472.80	665.40	6.61
Chest	88	72	160	234	260.24	354.68	3.90
Total	**659**	**628**	**1287**				

3.4. Estimating Cancer Risk

Table 7. Lifetime attributable Risk of all cancer's incidence.

CT Procedures	E moy (mSv)	Gender	Age													
			20		30		40		50		60		70		80	
			LAR	A.R	LAR	A.R	LAR	A.R	LAR	A.R	LAR	A.R	LAR	A.R	LAR	A.R
Abdomen-pelv	6.46	M	63.11	1584	44.31	2256	41.86	2388	38.17	2619	31.58	3166	22.15	4514	11.24	8896
		F	106.33	940	68.79	1453	57.23	1747	47.80	2092	37.85	2642	26.42	3785	13.82	7235
Head + IV	1.7	M	16.60	6024	11.66	8620	11.01	9082	10.04	9960	8.31	12,033	5.83	17,152	2.95	33,898
		F	27.98	3573	18.10	5524	15.06	6640	12.58	7949	9.96	10,040	6.95	14,388	3.63	27,548
Head − IV	1.4	M	13.67	7315	9.60	10,416	9.07	11,025	8.27	12,091	6.84	14,619	4.80	20,833	2.43	41,152
		F	23.04	4340	14.91	6706	12.40	8064	10.36	9652	8.20	12,195	5.72	17,482	2.99	33,444
cervical spine	3.05	M	29.79	3356	20.92	4780	19.76	5060	18.02	5549	14.91	6706	10.46	9560	5.30	18,867
		F	50.20	1992	32.48	3078	27.02	3700	22.57	4430	17.87	5595	12.47	8019	6.52	15,337

Continued

Lumbar spine	8.81	M	86.07	1161	60.43	1654	57.08	1751	52.06	1920	43.08	2321	30.21	3310	15.32	6527
		F	145.01	689	93.82	1065	78.05	1281	65.19	1533	56.62	1766	36.03	2775	18.85	5305
Sinus	0.30	M	2.93	34,129	2.05	48,780	1.94	51,546	1.77	56,497	1.46	68,493	1.02	98,039	0.52	192,307
		F	4.93	20,283	3.19	31,347	2.65	37,735	2.22	45,045	1.75	57,142	1.22	81,967	0.64	156,250
Petrous bone	1.86	M	18.17	5503	12.75	7843	12.05	8298	10.99	9099	9.09	11,001	6.37	15,698	3.23	30,959
		F	30.61	3266	19.80	5050	16.47	6071	13.76	7267	10.89	9182	7.60	13,157	3.98	25,125
Chest-abdomen-pelv	6.61	M	64.57	1548	45.34	2205	42.83	2334	39.06	2560	32.32	3094	22.67	4411	11.50	8695
		F	108.80	919	70.39	1420	58.56	1707	48.91	2044	38.73	2581	27.03	3699	14.14	7072
Chest	3.90	M	38.10	2624	26.75	3738	25.27	3957	23.04	4340	19.07	5243	13.37	7479	6.78	14,749
		F	64.19	1557	41.53	2407	34.55	2894	28.86	3465	22.85	4376	15.95	6269	8.34	11,990

Table 8. Lifetime attributable risk of all cancer's mortality.

Examen	E moy (mSv)	Gender	Age													
			20		30		40		50		60		70		80	
			LAR	A.R	LAR	A.R	LAR	A.R	LAR	A.R	LAR	A.R	LAR	A.R	LAR	A.R
Abdomen-pelv	6.46	M	33.01	3029	24.61	4063	24.35	4106	23.25	4301	20.60	4854	16.15	6191	9.88	10,121
		F	49.22	2031	35.01	2856	32.75	3053	30.29	3301	26.42	3785	20.47	4885	12.27	8149
Head + IV	1.7	M	8.68	11,520	6.47	15,455	6.40	15,625	6.12	16,339	5.42	18,450	4.25	23,529	2.60	38,461
		F	12.95	7722	9.21	10,857	8.61	11,614	7.97	12,547	6.95	14,388	5.38	18,587	3.23	30,959
Head – IV	1.4	M	7.15	13,986	5.33	18,761	5.27	18,975	5.04	19,841	4.46	22,421	3.50	28,571	2.14	46,728
		F	10.66	9380	7.58	13,192	7.09	14,104	6.56	15,243	5.72	17,482	4.43	22,573	2.66	37,593
Cervical spine	3.05	M	15.58	6418	11.62	8605	11.49	8703	10.98	9107	9.72	10,288	7.62	13,123	4.66	21,459
		F	23.24	4302	16.53	6049	15.46	6468	14.30	6993	12.47	8019	9.66	10351	5.79	17,271
Lumbar spine	8.81	M	45.01	2221	33.56	2979	33.21	3011	31.71	3153	28.10	3558	22.02	4541	13.47	7423
		F	67.13	1489	47.75	2094	44.66	2239	41.31	2420	36.03	2775	27.92	3581	16.73	5977
Sinus	0.30	M	1.53	65,359	1.14	87,719	1.13	88,495	1.08	92,592	0.95	105,263	0.75	133,333	0.45	222,222
		F	2.28	43,859	1.62	61,728	1.52	65,789	1.40	71,428	1.22	81,967	0.95	105,263	0.57	175,438
Petrous bone	1.86	M	9.50	10,526	7.08	14,124	7.01	14,265	6.69	14,947	5.93	16,863	4.65	21,505	2.84	35,211
		F	14.17	7057	10.08	9920	9.43	10,604	8.72	11,467	7.60	13,157	5.89	16,977	3.53	28,328
Chest-abdomen-pelvic	6.61	M	33.77	2961	25.19	3969	24.91	4014	23.79	4203	21.08	4743	16.52	6053	10.11	9891
		F	50.36	1985	35.82	2791	33.51	2984	31.00	3225	27.03	3699	20.95	4773	12.55	7968
Chest	3.90	M	19.92	5020	14.85	6734	14.70	6802	14.04	7122	12.44	8038	9.75	10,256	5.96	16,778
		F	29.71	3365	21.13	4732	19.77	5058	18.29	5467	15.95	6269	12.36	8090	7.41	13,495

4. Discussion

In this study, we performed asses the risks attributed to frequent CT scans for adult patients, due to the delivered doses and the patients age-gender. **Table 9** showing the doses found in our study for each procedure. These dases were compared to the results of 4 African countries, USA, Switzerland, Iranian and

Brazilian, studies [16]-[20].

Table 9. DRLs from our study compared with other study.

CT Procedures	Our study	African countries (2021)	USA (2017)	Switzerland (2010)	Iran (2018)	Brazil (2019)
	DLP	DLP	DLP	DLP	DLP	DLP
Abdomen-pelvic	715.20	737	995	650	524	878.22
Head	1289.20	1259	1011	1000	723	1503.6
Sinus	152.25	-		350	-	-
Petrous bone	1100.90	-	-	250	-	-
Chest	354.68	544	596	450	377	563
Chest-Abdomen-pelvic	665.40	-	1193	1000	-	-
Cervical spine	852.55	-	602	600	572	-
Lumbar spine	976.10	-	-	850	-	-

DLP (mGy.cm).

4.1. Patient Dose

The results show that, there exist dose variations for the same examination among CT facilities within compare to other study. These variations may result from user selections of different technical parameters as well as manufacturer-specific variations in the design of CT equipment. The dose from our study is globally higher than those in Switzerland (2010) and Iran (2018), apart from the sinus, chest and chest-abdomen-pelvic CT procedures. On the other hand, our CT dose are lower than those in Brazil (2019) and then those USA (2017), apart from the head and cervical spine protocol. Our patient-doses were in the similar ranges to those reported by Uushona *et al.* [16]. for African countries.

We used "effective dose" to quantify the radiation exposure associated with each CT scan, as it is one of the most commonly reported measurements. The effective dose takes into account the amount of radiation received by the exposed organs and the susceptibility of each organ to the development of cancer as a result of radiation exposure.

The average effective doses associated with the different types of procedures are between: 0.30 and 8.81 mSv. The highest effective dose was observed on the following examinations: the lumbar spine CT (8.81 mSv), chest-abdomen-pelvic CT (6.61 mSv), and abdomen-pelvic CT (6.46 mSv) (**Table 6**).

4.2. Estimated Lifetime Attributable Risk (LAR) for Cancer Incidence and Mortality

Table 7 and **Table 8** show the LAR values obtained for cancer incidence and mortality.

The LAR value describes the risk of cancer incidence and mortality due to exposures to ionizing radiation. LAR is defined as an additional cancer risk beyond the baseline cancer risk. This can be calculated for specific cancers as well as all cancers combined. The age and sex-specific LAR of all cancer incidences and mortalities for average effective doses, for each type of examination, was calculated using risk estimates from the BEIR VII preferred models. In this study, we used all cancers combined as an outcome to compare all selected CT scan types.

The risk of radiation-induced cancer varies according to the following factors: the exposure dose of the examination carried out, the age and sex of the patient. The LAR incidence and mortality from cancer in patients aged 20 to 80 who underwent CT examinations were estimated.

In our study, the LAR of the incidence of cancer from adult CT scans obtained varies between 0.52 per 100,000 scans (approximately 1 in 192307) and 145.01 per 100,000 scans (approximately 1 in 689) for the group of age 20 years and 80 years for lumbar spine and sinus CT scans. That of mortality between 67.13 per 100,000 scans (approximately 1 in 1489) and 0.45 per 100,000 scans (approximately 1 in 222,222) for the same age group for lumbar spine and sinus CT examinations. Thus, the highest LAR of cancers mortality 45.01 (male) and 61.13 (female) was observed in 20 years old who underwent a lumbar spine CT scan with an effective dose of 8.81 mSv.

The risks decreased significantly with age and were lower in men than in women, so radiation-associated cancer risks are of particular concern for younger female patients. It is precisely because the risks of cancer are so high in younger patients that special attention should be paid to optimizing CT examinations performed in younger patients 20 years of age.

The result obtained also showed that the LAR of cancer incidence is higher than the LAR of cancer mortality.

Generally, the risk of death due to cancer incidence after CT exposure is estimated to be 1 excess death per 2000 scans [21]. which was estimated to be in the same range in our study (1 excess death 1489 - 2221), based on the effective dose the higher than we observed, for the age group 20 years having undergone lumbar spine CT scan and chest-abdomen-pelvic CT scan. The LAR of mortality of cancer in all other examinations at different age groups was low in our study. The patient dose and consequent induced risk varied considerably from age group and gender for the same procedure. As we used the same model (BEIR VII) to predict the values LAR, this discrepancy may result from different exposure parameters used, resulting doses and age at exposure.

The study observed that the risk of cancer mortality ranged from low to minimal compared to the additional risk of fatal cancer attributable to the duration of life for diagnostic X-ray examinations show in **Table 10** [15]. Furthermore, by comparing these low risks with others causes of human death, it can be concluded that the Lifetime Attributable Risk of all cancer's mortality of these CT exams is in the range between the estimated Lifetime Risk of Death from Drowning as seen in **Table 11**.

Table 10. Risk of fatal cancer attributable to the duration of life for diagnostic X-ray examinations [15].

Procedure at 20 years old	Abdomen-pelvic	Head	Cervical spine	Lumbar spine	Sinus	Petrous bone	Chest-abdomen-pelvic	Chest
Approximate LAR	1 in 3029 - 1 in 2031	1 in 13,986 - 1 in 9380	1 in 6418 - 1 in 4302	1 in 2221 - 1 in 1489	1 in 65,359 - 1 in 43,859	1 in 10,526 - 1 in 7057	1 in 2961 - 1 in 1985	1 in 5020 - 1 in 3365

Table 11. Estimated lifetime risk of death from various sources [22].

Motor Vehicle Accident	1% or 1 in 100 chances
Drowning	0.1% or 1 in 1000 chances
Bicycle Accident	0.01% or 1 in 10,000 chances
Lightning	0.001% or 1 in 100,000 chances

Keep in mind, the majority of cancers occur later in life and the average lifetime risk of dying from cancer is 25% (1 in 4). These statistics are averages and do not predict what is going to happen for a specific individual. They do not take into consideration individual risk factors including lifestyle (smoking, diet, exercise, etc.), family history (genetics) or radiation exposure.

4.3. Limitations of the study

Our first study limitation was we estimated radiation doses received by patients in clinical practice, that the DLP data were estimates generated by CT scan software, which depend on scan acquisition parameters and the effective dose was estimated using DLP and k conversion factor, where as many previous studies have assessed the dose received in idealized settings on phantoms. Study parameters applied in phantoms may differ substantially (10% - 20% difference in the value obtained from the estimated effective dose using DLP and k conversion factor and measured effective dose) from those used in actual clinical settings [23]-[25]. LAR estimations were done using data from the BEIR VII report since the study did not have access to real data from epidemiological studies of cancer in the city of Douala; therefore, the LAR values obtained in this study are just approximated values and not the precise risk values.

5. Conclusion

This study has estimated the radiation doses delivered to the pediatric patients and the associated lifetime attributable risk (LAR) incidence and mortality for cancer from CT examinations. The LAR values were considerably higher for females than males, and higher for younger age group compared to older age group. Although the ten-radiology department recorded low to minimal LAR of all cancer incidence and mortality, the risk data presented here can be used to optimize the dose delivered to patients and also ensure that CT examinations are justified. The risk of cancer incidence and mortality can be significantly reduced when CT scans are performed using doses that are as low as reasonably achievable.

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Conflicts of Interest

The authors declare to have no competing interest in relation to this article.

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