Volume 19 Issue 43
Originally issued as D2

Global Journal of Medical Research: D
Radiology, Diagnostic and Instrumentation
Volume 19 Issue 2 Version 1.0 Year 2019
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4618 & Print ISSN: 0975-5888

Exposure of the Population of Ngaoundere-Cameroon to Ionizing Radiation Related to Medical Diagnosis in 2018

By Mathurin Neossi Guena, Baudouin Djoumessi Nanfack & Joseph Gonsu Fotsing

University of Ngaoundéré

Abstract- *Background:* Medical applications are the main source of exposure to ionizing radiation of human origin. Our objective was to determine the data on exposure to ionizing radiation of medical origin of the population of Ngaoundéré in 2018.

Methodology: It was a cross-sectional descriptive study conducted within a period of one year, in the different hospitals of Ngaoundéré, with a functional medical imaging service. The variables studied were age, sex, type of examination, anatomical region and effective dose. The statistical analysis was performed using the Microsoft Office 2016 software, Sphinx V5; the effective dosage was calculated using the Internet Dose calculation Module.

Keywords: *exposure, ionizing radiation, conventional radiology, city of ngaoundéré, 2018.*

GJMR-D Classification: *NLMC Code: QZ 241, QT 162.U4*



Strictly as per the compliance and regulations of:

© 2019. Mathurin Neossi Guena, Baudouin Djoumessi Nanfack & Joseph Gonsu Fotsing. This is a research/review paper, distributed under the terms of the Creative Commons Attribution-Noncommercial 3.0 Unported License http://creativecommons.org/licenses/by-nc/3.0/), permitting all non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Exposure of the Population of Ngaoundere-Cameroon to Ionizing Radiation Related to Medical Diagnosis in 2018

Mathurin Neossi Guena [α], Baudouin Djoumessi Nanfack [σ] & Joseph Gonsu Fotsing [ρ]

Abstract- Background: Medical applications are the main source of exposure to ionizing radiation of human origin. Our objective was to determine the data on exposure to ionizing radiation of medical origin of the population of Ngaoundéré in 2018.

Methodology: It was a cross-sectional descriptive study conducted within a period of one year, in the different hospitals of Ngaoundéré, with a functional medical imaging service. The variables studied were age, sex, type of examination, anatomical region and effective dose. The statistical analysis was performed using the Microsoft Office 2016 software, Sphinx V5; the effective dosage was calculated using the Internet Dose calculation Module.

Results: In 2018, 4136 diagnostic acts using ionizing radiation were carried out; it concerned only conventional radiology with an average of 0.02 per capita. The total collective dose received by the population was 8300 mSv, and an average dose of 0.040 mSv per inhabitant. The proportion of the population that has actually benefited from a conventional radiology examination is 2.07%, an individual effective average dose of 2 mSv.

The most frequent acts involved the thorax, limbs, spine and pelvis with respectively 53.9%; 19.6%; 14.3% and 6.7%. Acts involving the spine, pelvis and hip, skull and abdomen contributed the majority of the collective effective dose respectively with 39.99%, 25.96%, 10.53% and 8.84%. The age group performing most exams in men is 25 to 49 and 25 to 54 in women; the number of acts is higher among men 2457(59,4%) acts compared to women 1679(40,6%) acts. The collective dose per sex is higher among women with 4487.22 (54.06%) compared to men with 3812.98(45.94%).

Conclusion: Only 2.07% of population of Ngaoundere benefited from a conventional radiology examination in 2018 with an individual effective average dose of 2 mSv. The annual per capita effective dose in Ngaoundéré in 2018 is 0.040 mSv.

Keywords: exposure, ionizing radiation, conventional radiology, city of ngaoundéré, 2018.

I. Introduction

Medical applications are by far the largest source of exposure to ionizing radiation of human origin. Thus, diagnostic procedures account for more than 97% of artificial exposure and nearly 26% of total exposure of the population [1]. This exposure leads to absorption by the subject in contact with a dose likely to induce harmful biological effects on the body which are of two types, the so-called deterministic short-term effects directly related to cellular lesions for which a threshold of appearance has been defined and the so-called stochastic long-term or random effects dominated by cancers and genetic anomalies and which can develop from few hours to several years [1]. It would therefore be important to regularly estimate this medical exposure and analyze its evolution over time. A recent publication on the exposure of the population to ionizing radiation in the United States points out that medical exposure per year and per individual has increased six-fold, since the 1980s [2]. Directive 97/43/ Euratom [3] states in Article 12 on the estimation of doses received by the public: "Member States shall ensure that the distribution of individual doses generated by exposures for medical purposes is determined for the population and for the reference groups concerning it, depending on whether the Member States deems it necessary". The current revision of Directive 96/29/ Euratom [4] on basic radiation protection standards should introduce an additional requirement: "Member States shall ensure that the distribution of individual doses due to medical exposure is determined and takes into account the age and sex distribution of the exposed population". In recent years, many actions, both at European and American level, have been initiated in order to harmonize methods of collecting information and thus to have reliable indicators on the medical exposure of the population.

This is the case of the European Union's Dose Datamed project (2005-2007) which led to the publication of the report "radiation protection no. 154: European guidance on estimating population doses from medical x-ray procedures (2008)" [5] and the "International action plan for the radiological protection of patients" action plan led by the International Atomic Energy Agency (IAEA). Great Britain is undoubtedly the country that has done the most in this field because, in the late eighties, the National Radiological Protection Board (NRPB) set up a national system of dose evaluation. By type of examination based on

Author α σ: Department of Biomedical Sciences, Faculty of Sciences, Universityof Ngaoundéré, Ngaoundéré, Cameroon.
e-mail: mneossiguena@yahoo.fr
Author α: Imaging service, Ngaoundéré Regional Hospital, Ngaoundéré, Cameroon.
Author ρ: Faculty of Medicine and Biomedical Sciences, University of Yaounde I, Yaounde, Cameroon, Yaounde Gynaecology Obstetrics and Pediatrics Hospital, Yaounde, Cameroon.

© 2019 Global Journals

measurement campaigns conducted by a sentinel network of hospital services. Other countries, such as the Netherlands, Switzerland or Norway, also rely on annual activity data from all or some hospitals. For several years now, the fleet of heavy imaging equipments has expanded in Cameroon, with the creation of multiple imaging centers for public and private purposes therefore, an increase in examinations and protocols, with the result of irradiation of the population. However, the global exposure of the population to ionizing radiation of medical origin has never been evaluated in our country in general and in Ngaoundere in particular despite the creation of the National Radiation Protection Agency in 2002 with the primary mission of protecting people, goods and the environment against ionizing radiation [6].

It is also responsible for the dosimetry of patients, professionals, the public, the environment in the imaging services. This is why it is necessary to set up a long-term system to monitor practices both from the point of view of the knowledge of the nature, the frequency and the distribution of examinations in the population, then from the point of view of doses given to patients during these examinations. Thus, we proposed to conduct this pilot study to evaluate the medical exposure of the population of Ngaoundéré to ionizing radiation of medical origin in 2018, which could be the start point for monitoring these populations.

II. Methodology

The study was carried out in the two Hospitals with medical imaging departments equipped with ionizing radiation equipment in the city of Ngaoundéré, namely the medical imaging department of the Regional Hospital and the Patient Clinic. This was a descriptive cross- sectional study, conducted within a period of one year, from January to December 2018, including all patients coming to perform a medical imaging examination, using ionizing radiation. The diagnostic acts selected for the study were those of conventional radiology, which are the only ones currently performed in the city of Ngaoundere and grouped according to the anatomical zone explored. Finally, 25 areas were defined for this study. The variables studied were the frequencies of diagnostic procedures by anatomical region, age, sex, examination required, anatomical region, indication of examination, irradiation parameters and irradiation dose. The collection took place as practices in the imaging centers over a period of one year. The extrapolation of the results of the survey sample to the general population was based on data from the last census of the general population of Cameroon; which estimated the population of Ngaoundere at about 200,000 inhabitants. The study will therefore make it possible to estimate the population actually exposed to radio diagnostics in the public sector as well as in the private sector. In accordance with the recommendations of European Commission (EC) Report No. 154 [5], the dosimetric indicator used in this study to estimate the dose to the population related to medical exposure is the effective dose E (expressed in milli sievert, mSv) which is an indicator of the risk of health detriment linked to individual exposure to ionizing radiation. Being a standardized indicator, it allows comparisons between different countries and study of the evolution of the exposure that results from this or that type of act over time. Effective doses were calculated using the conversion factor values defined in ICRP Publication 60 [7]. From the number of Nt acts and the average effective dose and associated with each type of act t, it is possible to calculate the collective effective dose $S = \Sigma Et \times Nt$ [8]. The annual average effective dose per inhabitant is obtained by dividing the collective effective dose S by the total population size for the year studied, whether or not exposed to ionizing radiation. The statistical analysis was carried out using the software sphinx V5, Excel 2016 and the effective dose was calculated from the Internet Dose calculation Module (MICADO) online software of the National Institute for Radioprotection and Nuclear Safety (NIRNS) of France.

III. Results

a) Total number of acts and collective effective dose for the population of Ngaoundéré in 2018

It is estimated that 4136 diagnostic procedures were performed in Ngaoundéré from January to December 2018. Of the 4030 patients, of whom 2394 (59.4%) were men and 1636 (40.6%) women, the sex ratio was H/F of 1.5 (Figure 1) and an average act number of 0.02 per inhabitant, 2.07% of the population of Ngaoundere performed at least one conventional imaging examination in 2018, so 0.84% women and 1.22% of men. The mean age was 37 +/- 19.25 years with 1-month and 96-years extremes, the most represented age groups were 30-34 years with 378 (9.13%) cases, 35-39 years with 298 (7.20%) cases, 25-29 years with 266 (6.43%) cases, 40-44 years with 216 (5.22%) cases, 45-49 years with 214 (5.17 %) cases, and 20-24years with 202 (4.88%) cases (Table 1). The age group performing the most examination in men is 25-49 years and 25-54 years in the women.

© 2019 Global Journals

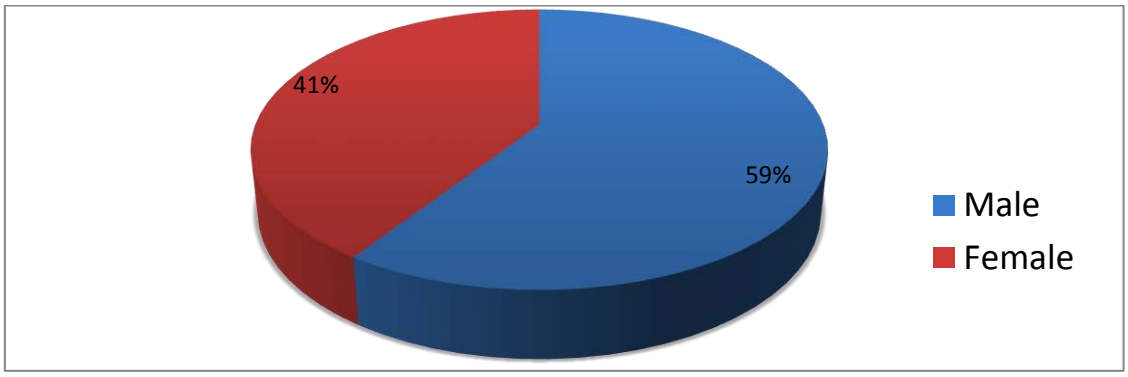


Figure 1: Distribution of acts performed by sex

Table 1: Distribution of number of acts performed by sex and age

Age group		Frequency of act			Total	
	Male	Percentage	Female	Percentage		Percentage
0-1	16	0,39%	28	0,68%	44	1.06%
1-8	50	1,21%	38	0,92%	88	2.13%
5-9	44	1,06%	50	1,21%	94	2.27%
10-14	64	1,55%	50	1,21%	114	2.76%
15-19	72	1,74%	38	0,92%	110	2.66%
20-24	140	3,38%	62	1,50%	202	4.88%
25-29	172	4,16%	94	2,27%	266	6.43%
30-34	252	6,09%	126	3,05%	378	9.13%
35-39	176	4,26%	122	2,95%	298	7.21%
40-44	154	3,72%	62	1,50%	216	5.22%
45-49	138	3,34%	76	1,84%	214	5.17%
50-54	76	1,84%	78	1,89%	154	3.72%
55-59	82	1,98%	52	1,26%	134	3.24%
60-64	100	2,42%	68	1,64%	168	4.06%
65-69	40	0,97%	34	0,82%	74	1.79%
70-74	40	0,97%	20	0,48%	60	1.45%
75-79	10	0,24%	24	0,68%	38	0.92%
80-84	18	0,44%	18	0,44%	36	0.87%
85-89	12	0,29%	8	0,19%	20	0.48%
90-94	6	0,15%	4	0,10%	10	0.24%
95 -	2	0,05%	2	0,05%	4	0.1%
Empty	792	19,14%	620	14,99%	1412	34.14%
Total	2457	59,38%	1679	40,57%	4136	100%

b) Distribution of acts and collective effective dose by anatomical area explored.

The most frequent acts involved the thorax, limbs, spine and pelvis with respectively 53.9%; 19.6%; 14.3% and 6.7% of cases (Table 2). The spine (lumbar and cervical spine), pelvic (pelvis, hip and hysterosalpingography (HSG)), skull and abdomen (intravenous urography, barium enema (BE) and abdomen without preparation (AWP) acts contributed to the majority of the collective effective dose with 39.99%, 25, 96 %, 10,53 and 8,84 % respectively, the total effective dose S resulting from all the acts is equal to 8300 mSv (Table 3).

Table 2: Distribution of imaging by anatomical region and sex

Exams	Workforce				Total	
	Male		Female			
AWP	50	1,21%	28	0,68%	39	1,89%
FOREARM	62	1,50%	28	0,68%	45	2,18%
ARM	62	1,50%	50	1,21%	16	0,77%
BASIN	16	0,39%	16	0,39%	56	2,71%
ANKLE	70	1,69%	40	0,97%	55	2,66%
CLAVICLE	6	0,15%	12	0,29%	9	0,44%
ELBOW	22	0,53%	10	0,24%	16	0,77%

© 2019 Global Journals

SKULL	124	2,99%	58	1,40%	91	4,40%
FEMUR	46	1,11%	28	0,68%	47	2,27%
KNEE	94	2,27%	56	1,35%	75	3,63%
HIP	66	1,60%	34	0,82%	50	2,41%
HSG	0	0%	68	1,64%	34	1,64%
LEG	112	2,71%	60	1,45%	86	4,16%
BE	4	0,1%	8	0,19%	6	0,29%
HAND	28	0,68%	18	0,44%	23	1,11%
FOOT	28	0,68%	22	0,53%	25	1,21%
WRIST	18	0,44%	12	0,29%	15	0,73%
CERVICAL SPINE	32	0,77%	20	0,48%	26	1,26%
DORSAL SPINE	26	0,63%	18	0,44%	22	1,06%
LUMBAR SPINE	238	5,75%	252	6,09%	245	11,85%
THORAX	1348	32,59%	880	21,28%	1114	53,87%
DGOT	2	0,05%	0	0%	1	0,05%
IVU	12	0,29%	2	0,05%	7	0,34%
URETHROCYSTOGRAPHY	6	0,15%	0	0%	3	0,15%
SHOULDER	66	1,60%	34	0,82%	50	2,41%
TOTAL	2457	59,38%	167	40,57%	2068	100%

Table 3: Collective Dose Associated with Each Type of Examination

Examens	Dose Collective (mSv)	Percentage
AWP	134,98	1,63%
FORE ARM	24,82	0,30%
BASIN	486,9	5,87%
ARM	4,42	0,05%
CLAVICLE	13,6	0,16%
ANKLE	13,36	0,16%
ELBOW	4,72	0,06%
FEMUR	18,16	0,22%
KNEE	26,02	0,31%
HIP	520,58	6,27%
HSG	1147,62	13,83%
LEG	33,16	0,40%
HAND	3,38	0,04%
BE	254,12	3,06%
FOOT	5,56	0,07%
WRIST	3,22	0,04%
CERVICAL SPINE	352	4,24%
DORSAL SPINE	473,54	5,78%
LUMBAR SPINE	2967,26	35,75%
SHOULDER	138,24	1,67%
URETHROCYSTOGRAPHY	74,96	0,90%
DGOT	28,50	0,34%
THORAX	346,56	4,18%
IVU	344,66	4,15%
SKULL	873,6	10,53%
TOTAL	8300	100%

c) The most frequent acts by sex and age

The data presented in Table 4 and Figures 2 to 6 provide the following information: The exposure of patients under five years is primarily in the chest region with 23.52% for males and 30.88% for females. For limbs, 29.417% males and 13.23% females for limbs, and skull 2,94% for males and 0% for females, no pelvic x-ray under five years. For children aged 5 to 20 years, irradiation affects the majority of limbs with 32.11% for males and 13.13% for females. For adults between 21 and 50 years old, this irradiation concerns all the most frequent acts. As early as the age of 50 years, radiation is predominant for thoracic, lumbar spine and pelvic examinations; in general, the male sex is more representative of the irradiated anatomical area.

© 2019 Global Journals

Table 4: Distribution of the number of acts for the most frequent examinations and by sex and age

Exams	Thorax		Lumbar spine		Members		Pelvis		Skull	
Sex	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0-1	8	18	0	0	6	8	0	0	2	0
1-4	24	24	0	0	34	10	0	0	2	0
5-9	4	30	2	2	22	10	4	0	0	2
10-14	24	16	2	2	32	12	0	4	4	0
15-19	24	20	2	2	34	14	4	0	2	0
20-24	70	24	14	6	40	8	4	8	10	8
25-29	112	52	8	8	40	12	12	12	6	6
30-34	190	62	20	18	40	10	6	14	6	0
35-39	126	80	8	26	24	16	0	16	4	2
40-44	108	30	16	12	20	10	6	2	2	0
45-49	60	46	22	18	24	8	8	2	2	4
50-54	44	48	8	6	18	8	10	2	0	2
55-59	50	16	8	10	8	22	6	0	2	2
60-64	54	34	6	12	18	4	10	6	0	0
65-69	20	16	0	6	6	12	2	0	0	0
70-74	22	16	10	4	6	0	2	2	0	0
75-79	10	12	6	6	0	2	0	2	0	0
80-84	18	18	2	0	0	0	2	2	2	2
85-89	10	4	2	0	0	2	0	0	0	0
90-94	6	4	2	0	0	0	0	0	0	0
95-	0	2	0	0	0	0	0	0	0	0
Empty	374	296	100	114	320	242	70	74	66	44
Total	2228	868	490	252	924	410	280	146	182	72

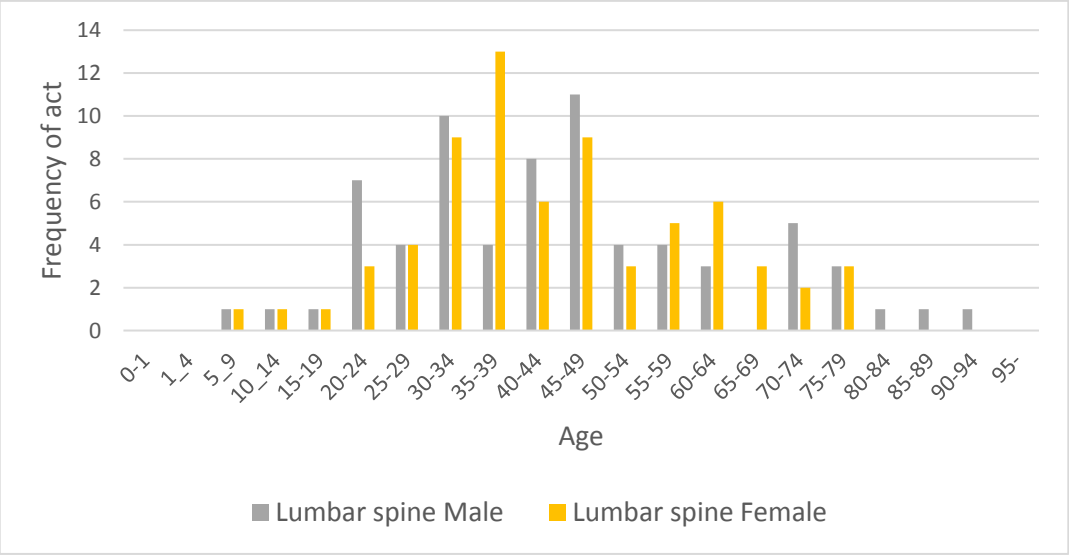


Figure 2: Distribution of the number of lumbar spine acts by age and sex

© 2019 Global Journals

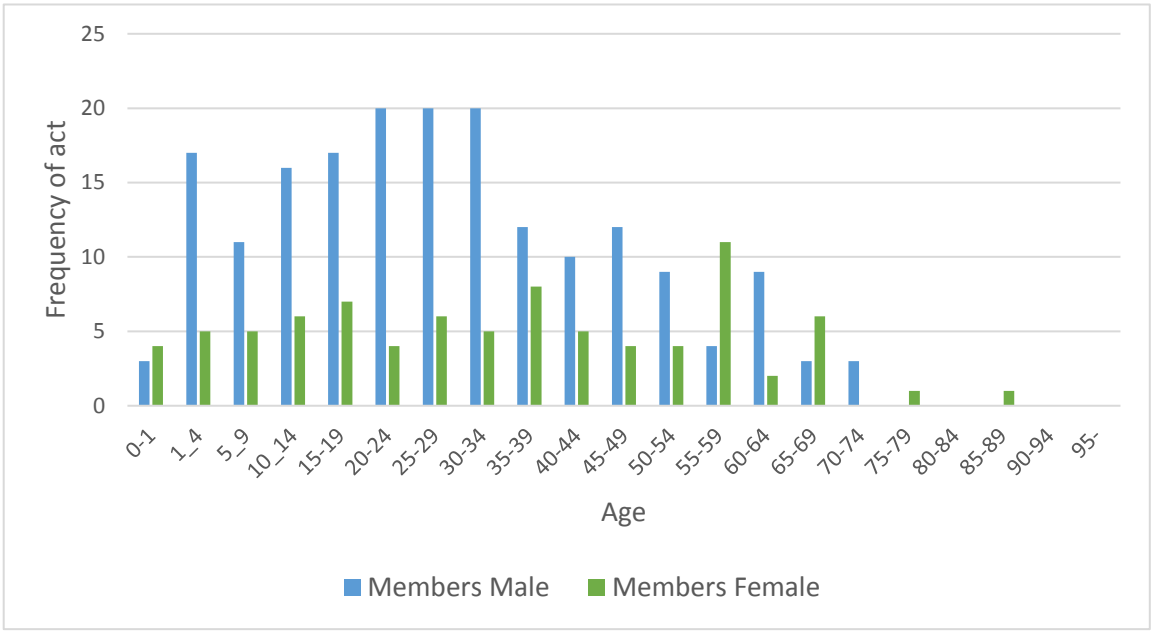


Figure 3: Distribution of number of members' acts by sex and age

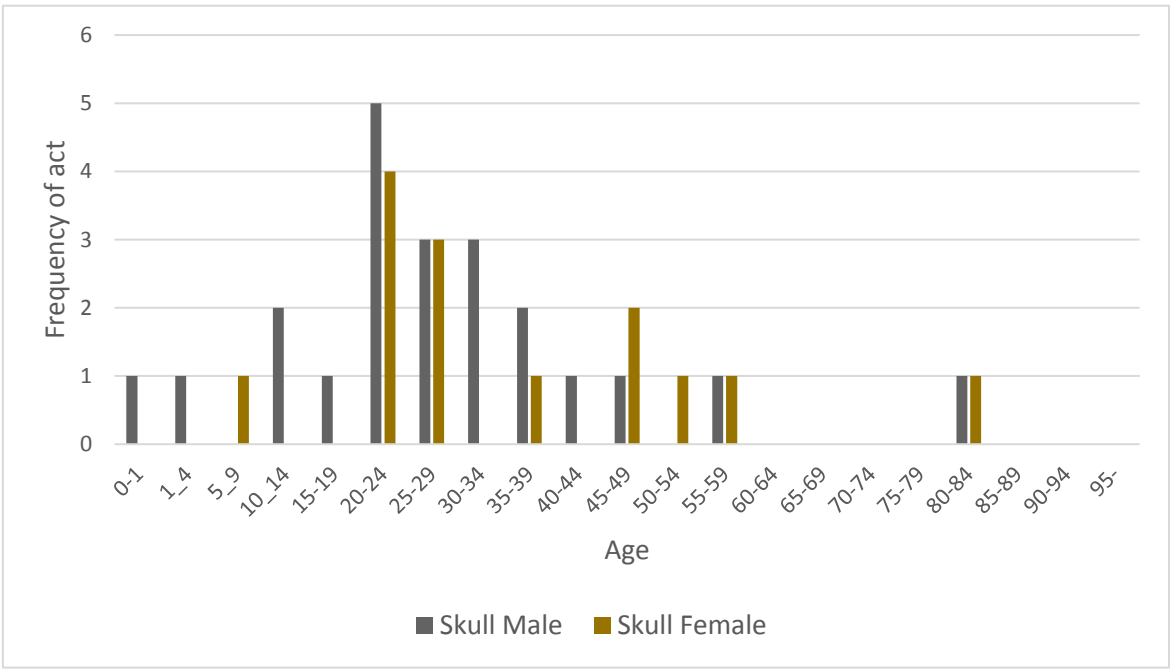


Figure 4: Skull act number distribution by age and sex

© 2019 Global Journals

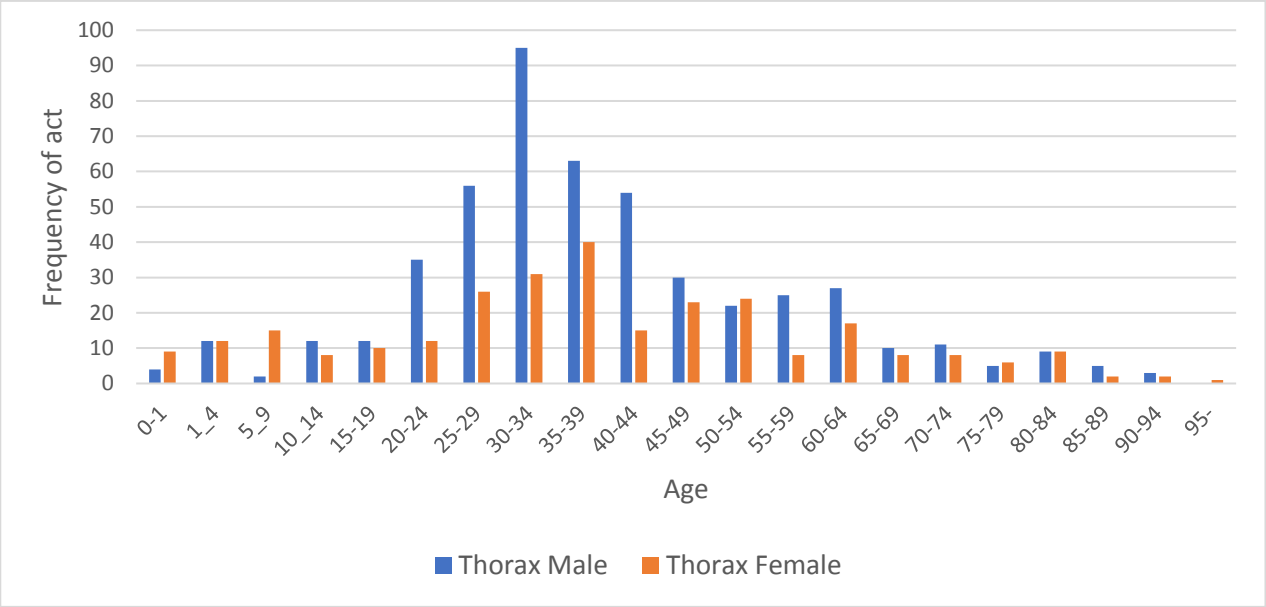


Figure 5: Distribution of the number of thorax acts by sex and age

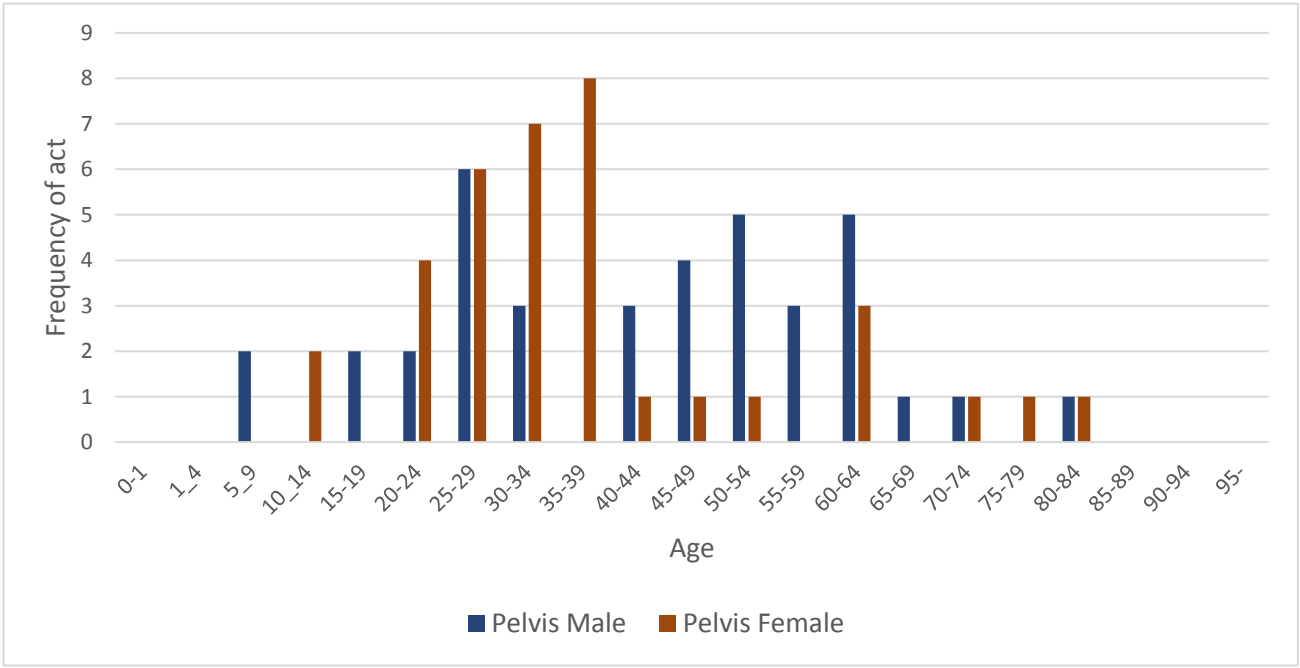


Figure 6: Distribution of number of pelvis acts by sex and age

d) Average effective dose per inhabitant at Ngaoundere in 2018

According to National Institute of Statistics (NIS) data, the population of Ngaoundere is about 200,000, which leads to an average collective effective dose of 0.04 mSv per capita in the general population. The individual average effective dose in 2018 for the population actually exposed (2.07% of the total population) is 2 mSv, according to sex 2.67 mSv in women and 1.55 mSv in men. The most irradiated age group ranges from 20 to 64 years with a dose of 4680.66 mSv (56.39%), the 30-34-year groups receive 896.76 mSv (10.80%) and 35 -39 years 706.7 mSv (8.51%) (Table 5 and figure 7). The collective dose amount per sex is higher among women with 4487.20 mSv (54.06%) than men with 3812.98 mSv (45.94%) (Figure 8).

© 2019 Global Journals

Table 5: Distribution of collective effective dose by sex and age

Age group	Dose (mSv)				Total	
	Male		Female			
0-1	4,76	0.06%	7,06	0.09%	11,82	0,14%
1-4	17,98	0.22%	8,3	0.1%	26,28	0,31%
5-9	32,58	0.39%	17,02	0.21%	49,6	0,60%
10-14	42,3	0.51%	109,66	1.32%	151,96	1,83%
15-19	51,98	0.63%	28,44	0.34%	80,42	0,97%
20-24	151,7	1.83%	317,18	3.82%	468,88	5,65%
25-29	218,68	2.63%	365,78	4.41%	584,46	7,04%
30-34	340,3	4.1%	556,46	6.70%	896,76	10,80%
35-39	324,32	3.91%	382,38	4.61%	706,7	8,51%
40-44	231,7	2.79%	198,16	2.39%	429,86	5,18%
45-49	340,92	4.1%	243,66	2.94%	584,58	7,04%
50-54	237,08	2.86%	100,32	1.21%	337,4	4,07%
55-59	161,18	1.94%	135,38	1.63%	296,56	3,57%
60-64	197,12	2.37%	178,34	2.15%	375,46	4,52%
65-69	58,042	0.70%	27,82	0.34%	85,86	1,03%
70-74	109,86	1.32%	38,02	0.46%	147,88	1,78%
75-79	19,38	0.23%	96,06	1.16%	115,44	1,39%
80-84	32,94	0.40%	30,7	0.37%	63,64	0,77%
85-89	15,76	0.19%	0,98	0.012%	16,74	0,20%
90-94	13,52	0.16%	0,50	0.01%	14,02	0,17%
95 -	29,94	0.36%	12,6	0.15%	42,54	0,51%
Empty	1180	14.22%	1632,4	19.67%	2812,4	33,88%
Total	3812,96	45,94%	4487,22	54,06%	8300	100%

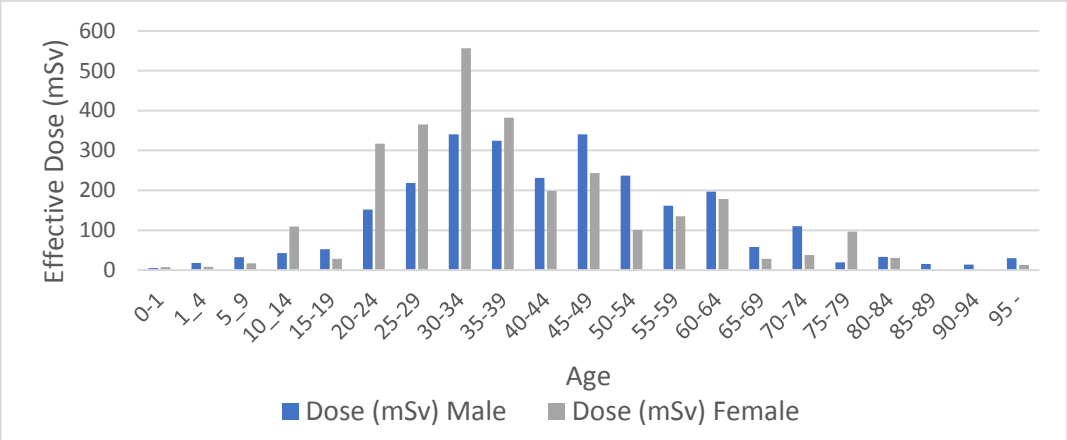


Figure 7: Distribution of collective effective dose by sex and age

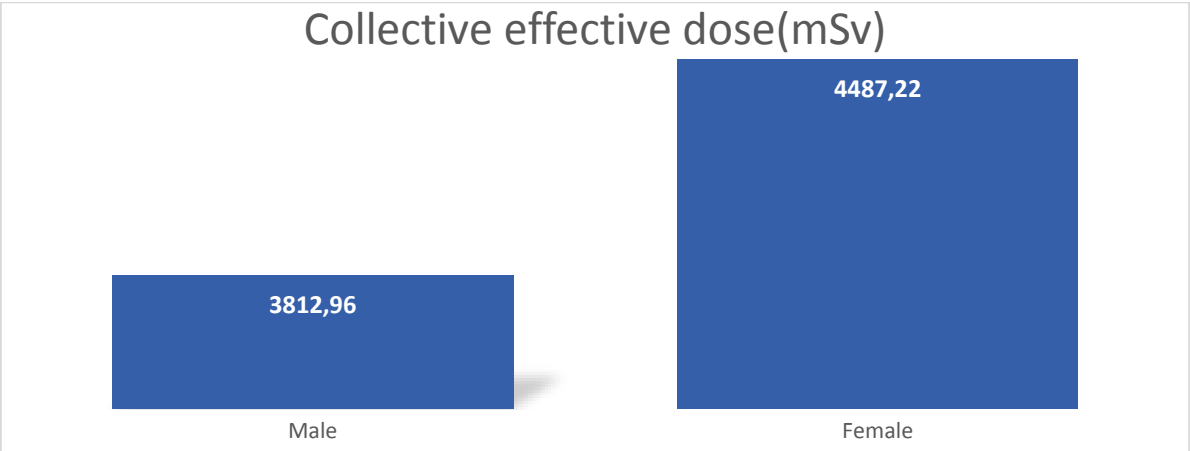


Figure 8: Collective effective dose by sex

© 2019 Global Journals

IV. Discussion

a) Frequency of act

The number of conventional radiology acts per anatomical region per 1,000 inhabitants in Ngaoundéré in 2018 is 20.68, which is lower than those achieved in France with 744 acts in 2007; Switzerland 762 acts in 1998; Norway 742 acts in 2002; Germany with 1,080 acts in 2003, Belgium with 1,160 acts in 2001 and the United States with 1,033 acts in 2006 [8]. Indeed, the development of medical imaging is recent in the city of Ngaoundere, many equipment are outdated, operating intermittently. The high price of imaging exams relative to the average income of populations is a handicap to examinations. The low number of these examinations also makes it possible to limit the irradiation of the population. Imaging is varied across all anatomical regions with predominance of the thorax which accounts for more than half of the acts with 53.9% followed by limbs with 24.23% and the lumbar spine with 11.85%. Specialized examinations are very rare, hysterosalpingography (HSG) is 1.64%, intravenous urography (IVU) 0.34%, barium enema (BE) 0.29%, urethrocystography0.15 % and duodenal gactro esophageal transit (DGOT) 0.05%. The high frequency of an act takes into account its involvement in the management of common pathologies, this is the case of chest x-ray whose involvement in the management of pulmonary, cardio-mediastinal and costal pathologies is more to demonstrate. In addition this examination is strongly realized within the framework of the visits of employment, the systematic medical visits and even the visits before the registration in universities, the granting of a visa to travel in certain countries [9] which is not the case for examinations such as limbs, spine, skull whose indications are more specific and limited, often occurring in cases of trauma, pain and lameness.

Our data are similar to those of France recorded in the National institute of Health and Medical Research report of 1994 [10] where the chest x-ray represents 31%, followed by the spine of 8.3%. As for the specialized exams, their request is rather weak because of the absence in our city of the specialists being able to request these examinations; more over they are rather expensive. Chest x-rays are found at all ages, with the limbs predominantly 0-5 years old, the pelvis predominating in adolescents up to 50 years, and the lumbar spine predominantly at the age of 50 years and more. The distribution of x-rays according to the age marries the pathologies which concern these age groups, the thoracic pathologies are found at all the ages, those of the limbs concern the children and the young adults, the pelvis and the lumbar spine mainly concern the adults. Our data corroborate those of Switzerland [11] where it was examined by x-ray of patients under five, from the thorax region, for children aged five and over, radiography mainly affects the limbs and joints for adults under 50 years, this radiation is also mainly followed by the limbs and the thorax, from 50 years. Hence, the thorax dominates.

b) Effective Dose

The amount of collective dose per sex is higher among women with a total of 4487.22 mSv (54.06%) compared to men with a total of 3812.96 mSv (45.94%). Among the most irradiating examinations are the lumbar spine and the pelvis, these are examinations concerning thick areas and composed of very dense structures that require a significant load in terms of kilo voltage and milli ampere and therefore a high dose of radiation to cross them. The annual effective dose per inhabitant in Ngaoundere in 2018 of 0.04 mSv is lower than that of the United Kingdom with 0.41 mSv, Denmark 0.46 mSv excluding nuclear medicine, the Netherlands 0.52 mSv, Sweden 0.72 mSv, France in 2007 1.29 mSv, Norway 1.15 mSv in 2002, Luxembourg 1.98 mSv in 2002, Belgium 1.97 mSv in 2001, Germany 1, 76 mSv in 2003, United States 3 mSv in 2006 [8] and Switzerland 1.07 mSv in 1998, 1.21 mSv in 2008 and 1.42 mSv in 2013 [11].It should be noted that, the annual per capita effective dose in Ngaoundéré in 2018, equal to 0.04 mSv, is lower than the European and American average values and to the natural irradiation which is 2.4 mSv [12]. This wide difference in dose can be explained by the presence of numerous radio diagnostic procedures including CT and nuclear medicine and a wide range of protocols by modality in these countries and also the very high number of irradiating acts in these cities compared to the city of Ngaoundere. In conventional radiology, the acts exposing the abdomen (Spine, IVU, BE and AWP), the pelvis (pelvis, hip and HSG) and the skull contribute mainly to the collective effective dose with respectively 48.83%, 25.96% and 10.53% of the collective effective dose, which is the same with data from France 2007 [8] where the acts exposing the abdomen, the pelvis and the digestive tract contribute mainly to the collective dose with 41, 5%, 29.8% and 11.8% of the collective effective dose. These are exams for which a large amount of irradiation is used and the contrast examinations are dynamic, requiring multiple incidences and shots.

V. Conclusion

At the end of this study, it appears that, the medical exposure to ionizing radiation in Ngaoundere is mainly done by conventional radiology, the total number of examination is 4136 is an average number of act of 0.02 act per inhabitant, the examinations are more frequently performed in men and the irradiation is more important for women, the most affected age groups are those aged 25 to 49 for men and 25 to 54 for women. The most common examinations are the thorax, the

© 2019 Global Journals

limbs, the lumbar spine and the skull; the most radiating examinations are the lumbar spine, the abdomen and the pelvis. The collective effective dose is 8300 mSv with 4487.22 mSv in women and 3812.96 mSv in men, an effective average dose per capita of 0.04 mSv well below European, US and natural irradiation values. The proportion of the population that has actually benefited from a conventional radiology examination is 2.07%, an individual effective average dose of 2 mSv per person.

Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

References Références Referencias

1. Rannou A., Aubert B., Scanff P. (2006) Exposure of the French population to ionizing radiation. Report IRSN/DRPH/SER 2006-02. Available on www.irsn.fr
2. National Council on Radiation Protection and Measurements. Ionizing radiation exposure of the population of the United States. NCRP report n° 160, 2009. Available on www.ncbi.nlm.nih.gov
3. Directive 97/43/Euratom of 30 june 1997, on the protection of the health of persons against the dangers of ionizing radiation when exposed for medical purposes. Available on www.asn.fr
4. Directive 96/29/Euratom of 13 may 1996 laying down basic standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation. Available on www.asn.fr
5. European Guidance on Estimating Population Doses from Medical X-Ray Procedures, Radiation Protection n° 154, European Commission, DG Energy-Transport (2008).
6. République du Cameroon (2002). Décree n° 2002/250 of 31 octobre 2002 establishing, organisation and operating the National Radiation Protection Agency. Available on www.ilo.org
7. International Commission on Radiological protection. 1990 recommandation of the international commission on radiological protection. Publication 60 of the CIPR (1990) French language edition Pergamon Press, Oxford. Available on www.asn.fr
8. Cecile E., Sandra S., Bernard A.(2012) Exposure of the French population to ionizing radiation related to the medical diagnostic procedures in 2007 — Institut de veille sanitaire. Available www.irsn.fr
9. Boniface M., Joshua T., Walter P., Fernande Z, Emrick G, Joseph G. Assessing the role of routine chest radiography in asymptomatic students during registration at a university in an endemic area of tuberculosis. Ann Trop Med Public Health 2012; 5: 419-22.
10. Pascale S., Jean D., Phillipe P. et Bernard A. Exposition de la population française aux rayonnements ionisants – Institut de veille sanitaire. Disponible sur le site www.irsn.fr
11. Le Coultre R., Bize J., Champendal M., Wittwer D., Trueb P., Verdun F. (2015) Exposition de la population suisse aux rayonnements ionisants en imagerie médicale en 2013 Rapport final Juillet 2015. Disponible sur le site www.bag.admin.ch
12. United Nation, Report of the United Nations Scientific Committee on the Effects of Atomic Radiation, Fifty-sixth sessions (10-18 July 2008). General Assembly Official Records Sixty-third Session Supplement No. 64.

© 2019 Global Journals