

Comparative analysis of medical exposure to ionizing radiation – the 2021 National Report and the 2020/2021 UNSCEAR Report

Olga Gîrjoabă, Diana Mocăniță, Vasilica Ion

National Institute of Public Health - Romania

Introduction

United Nations Scientific Committee on the Effects of Atomic Radiation

SOURCES, EFFECTS AND RISKS OF IONIZING RADIATION
UNSCEAR 2020/2021 Report

Volume I
REPORT TO THE GENERAL ASSEMBLY
SCIENTIFIC ANNEX A:
Evaluation of medical exposure to ionizing radiation



Medical exposure – the most important anthropic source in terms of population exposure – highlighted by:

- **UNSCEAR 2008 Report**
- **UNSCEAR 2020/2021 Report**

The permanent development of radiological and imaging technologies and their more and more intensive use, implicitly leads to an increase in the collective dose both nationally and internationally

Scope and Objectives

- **Scope** - improving the situation at the national level in terms of examination frequency, as well as reducing the radiation doses received by patients from medical exposures by optimizing the exposure protocols.
- **Objectives** - analysis of the results obtained in the National Report regarding the centralized situation of the data recorded in 2021 by Romanian providers of radiology, nuclear medicine and radiotherapy services, in comparison with the results obtained internationally in the UNSCEAR 2020/ 2021 Report .

Materials and method

- ❑ Romania's contribution to the UNSCEAR 2020/2021 Report was based on the data recorded and reported annually by the radiology, nuclear medicine and radiotherapy departments to the Radiation Hygiene Laboratories (LIR) network within the territorial public health authorities (DSP) and National Institute of Public Health (INSP)
 - ▶ *data processing and centralization was carried out at the local level by the Radiation Hygiene Laboratories within the territorial DSPs, and at the national level by the National Institute of Public Health*

- ❖ The medical exposures to ionizing radiation are monitored annually at national level according to the following provisions:
 - ***Norms regarding the basic requirements of radiological security***
 - ***Norms regarding the registration, centralization and reporting of information concerning medical exposure of the population to ionizing radiation,***

as part of the program to implement in Romania the European Directive 2013/59/EURATOM

❖ **UNSCEAR 2020/2021 Report**

- based on the contribution of 61 countries from all continents
- the data were collected between 2009-2018 and transmitted through successive annual national reports

❖ Annex A to UNSCEAR 2020/2021 Report and National 2021 Report on *evaluation of medical exposure to ionizing radiation* - presents the estimation of

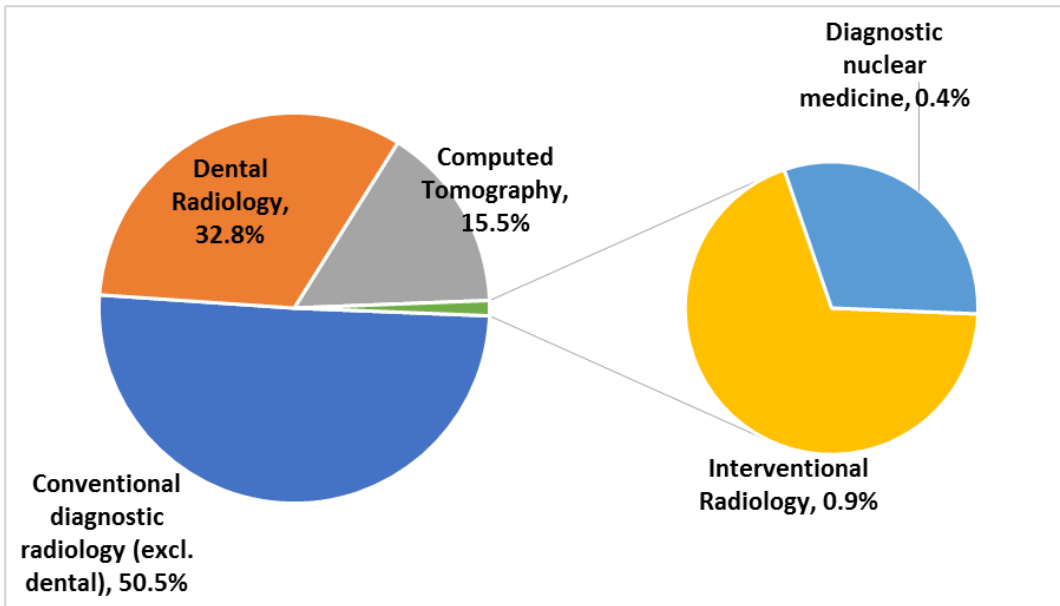
- **annual frequencies** of the main types of examinations/procedures, including the distribution by age and gender groups
- **average radiation doses** received by patients, for each type of examination/procedure.

The information collected, processed and evaluated both in the National 2021 Reports and in the UNSCEAR 2020/2021 Report refer to the following indicators:

- **number of radiological examinations** per type of examination / procedure,
- **distribution** of radiological examinations / procedures **by age and gender groups**,
- average doses by type of examination / procedure:
 - **dose - area product DAP (Gy x cm²)** *for diagnostic radiological examinations and interventional procedures,*
 - **dose - length product DLP (mGy x cm)** *for computed tomography procedures,*
 - **mean glandular dose MGD (mGy)** *for mammography,*
 - **administered activity of the radiopharmaceutical (MBq)** *for nuclear medicine procedures,*
- **mean effective dose** per type of examination / procedure.

Results

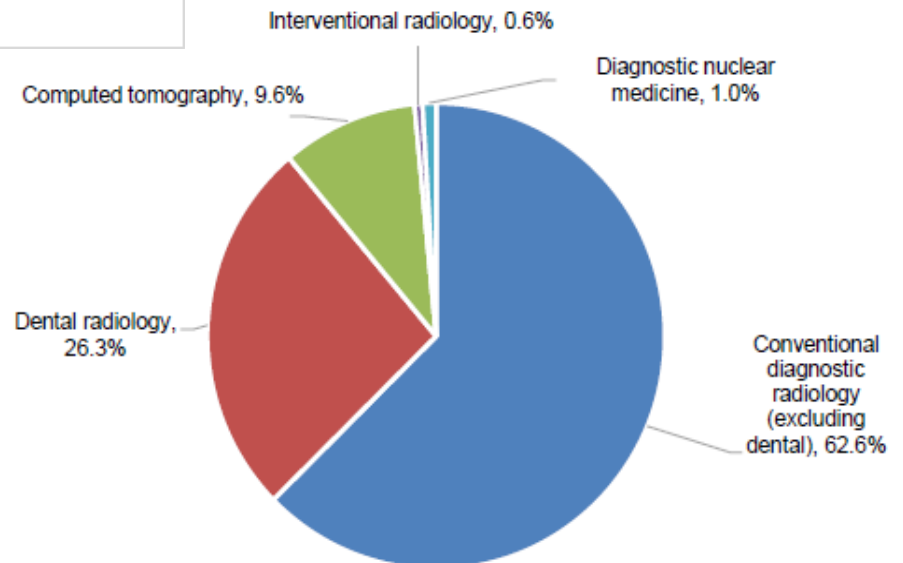
Distribution of types of diagnostic examinations/procedures and their contribution to the total number of examinations / procedures



performed in Romania in 2021



performed annually at international level (during the period 2009-2018)

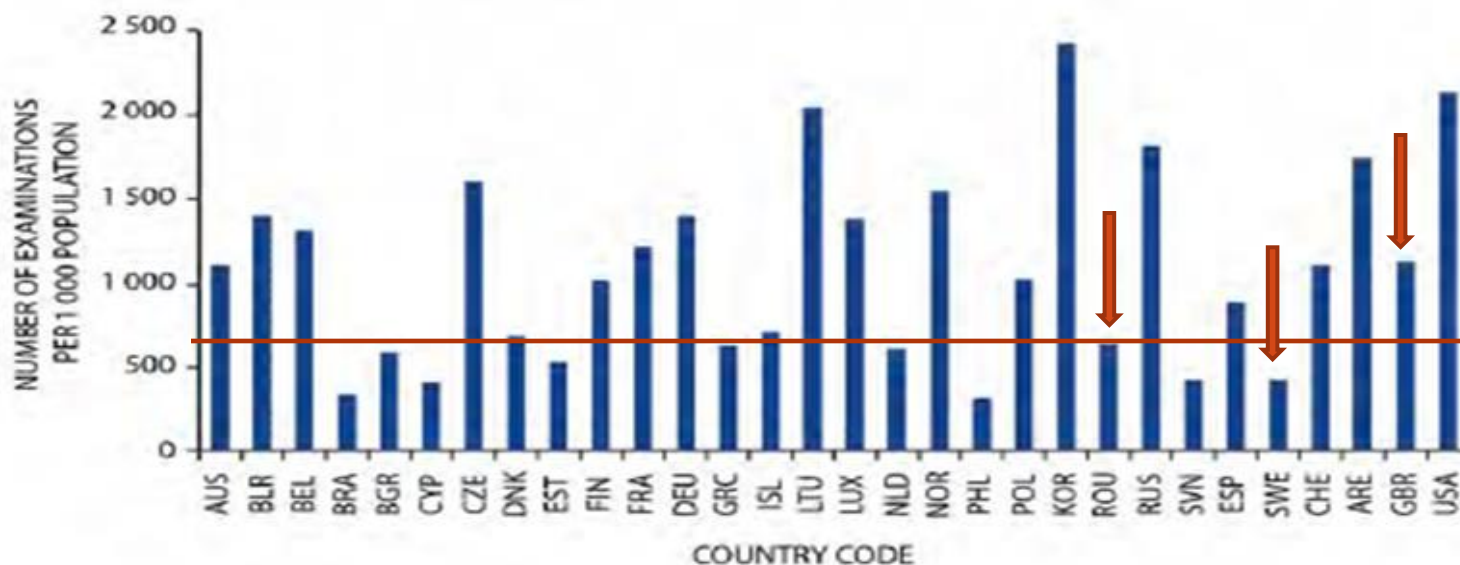


- The examination frequency must be analyzed taking into account that, from the point of view of the number of radiologists (88) per 1,000,000 inhabitants, according to the UNSCEAR classification, Romania is in category IV regarding the level of patients access to radiological services, respectively to less than 1 radiologist per 10,000 inhabitants
- The number of radiological equipment is relatively low, 1 radiological equipment per 4400 inhabitants.



Distribution of the number of CT equipment per 1 million inhabitants for European countries, according to the UNSCEAR 2020/2021 Report

Identification of the current situation in Romania from the point of view of examination frequency in relation to the developed countries of the world

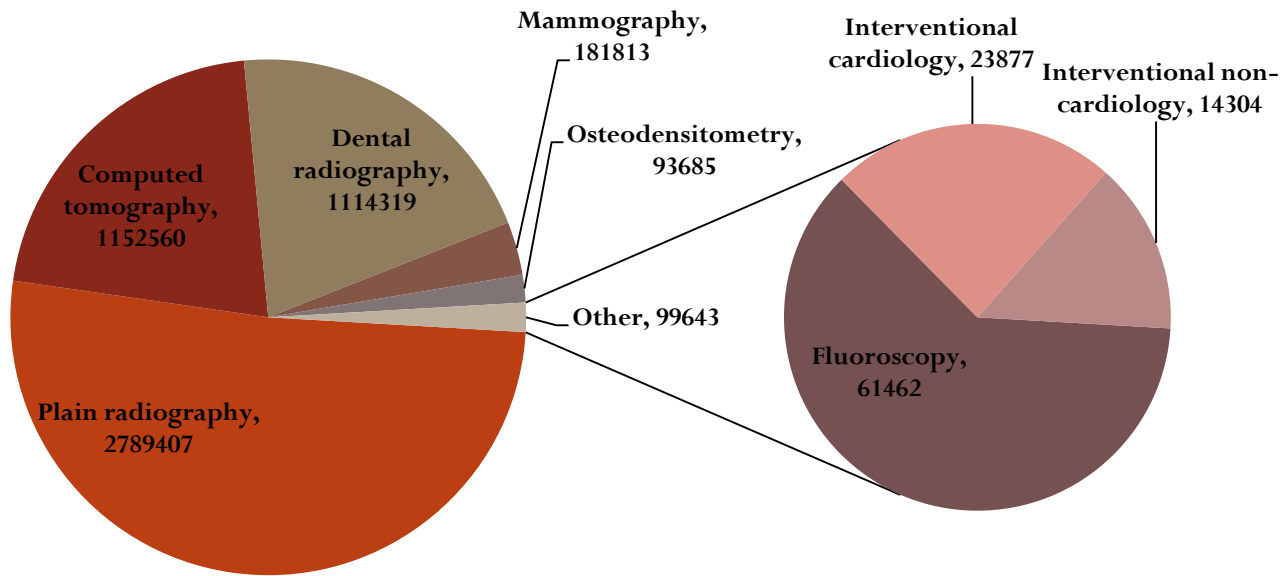


Examination frequency per 1,000 inhabitants for diagnostic radiology (conventional radiology, exclusively dental, and computed tomography), according to the UNSCEAR 2020/2021 Report

The frequency of examination and the number of equipment compared to Romania is:

- higher in UK /GBR, although the number of equipment is smaller,
- lower in Sweden, although the number of equipment is much higher

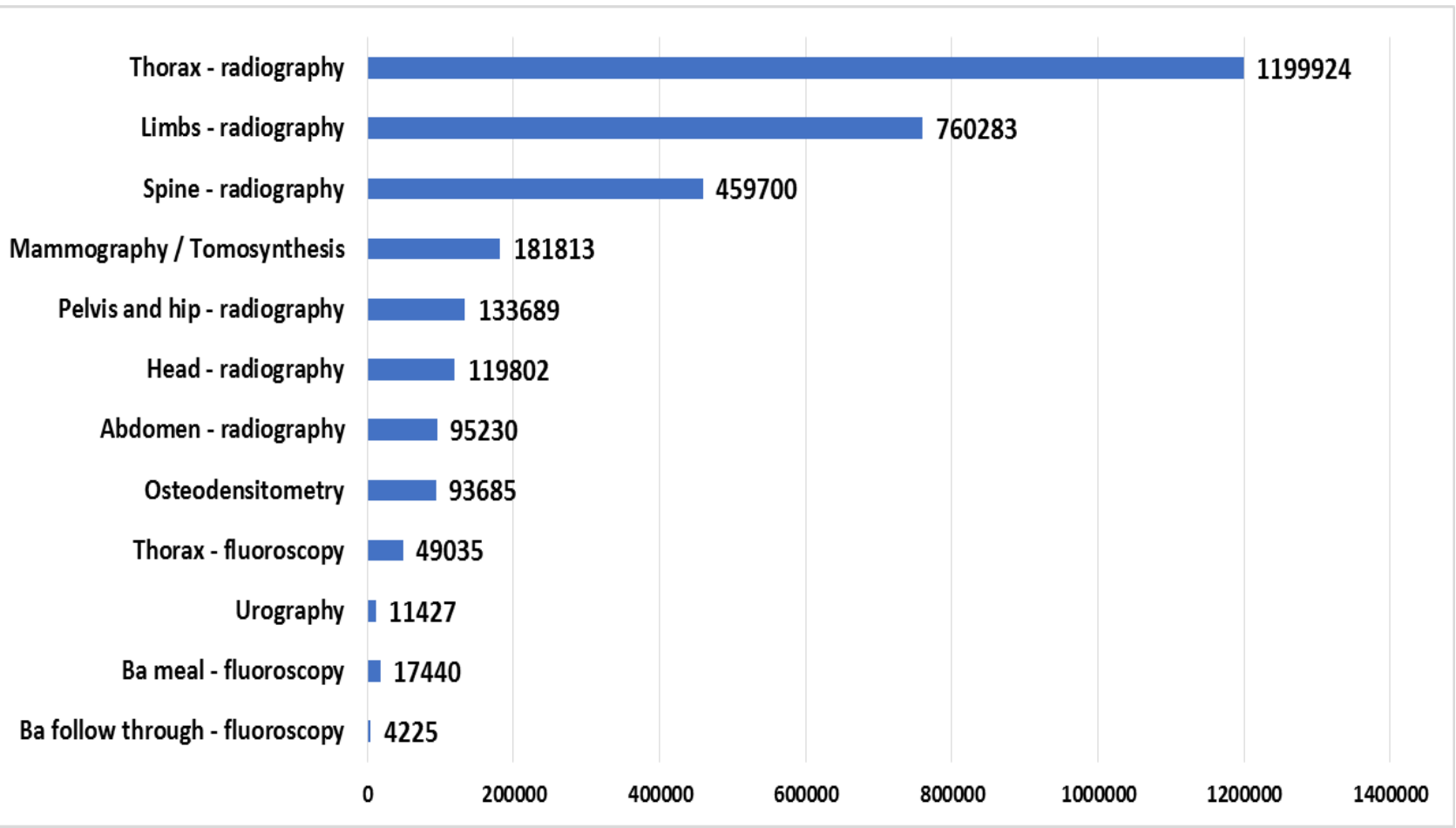
The distribution of the reported number of diagnostic and interventional radiology examinations/procedures at national level in 2021



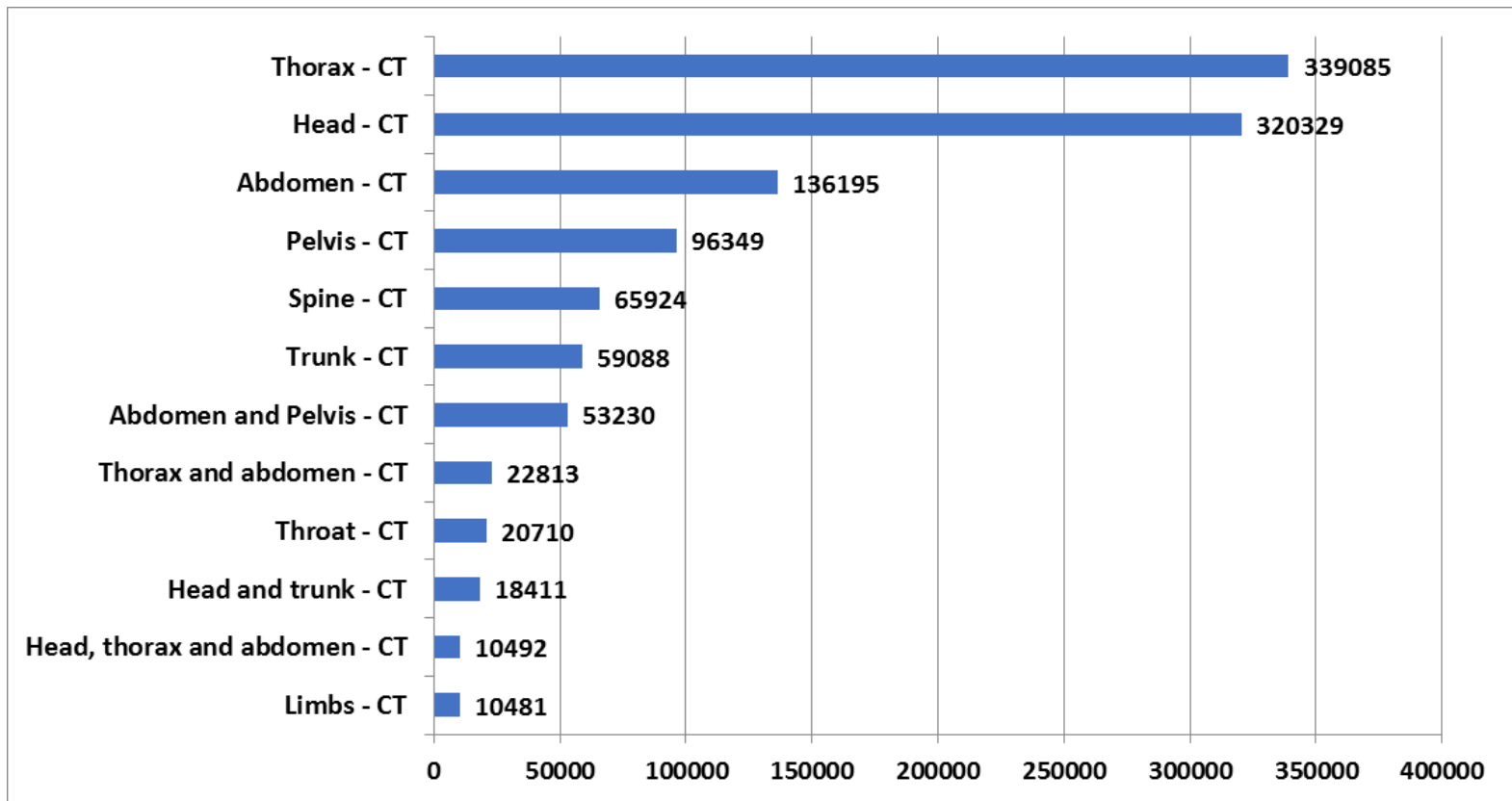
The values mentioned in this graph reflect the number of examinations reported by the medical units

The reporting percentage varies depending on the type of radiological equipment

- 57% for radiography and fluoroscopy,
- 65% for computed tomography,
- 40% mammography and interventional radiology,
- 30% dental radiology



Distribution of the number of examinations/procedures reported in the case of conventional radiology, according to the 2021 National Report



Distribution of the number of examinations/procedures reported in the case of computed tomography, according to the 2021 National Report

At the level of 2021, unlike all other previous years, the National Report highlights the fact that **the CT examination frequency was higher for chest than that for head**, thus occupying the first position in the top of the most frequent CT examinations for the first time, this situation being due to the investigation needs caused by the Covid 19 pandemic.

❑ ***The most frequent conventional radiological examinations***

- At **national** level (annual national report) -- thoracic region, limbs and joints, spine - all segments, mammography, pelvis, head and abdomen;
- At **international** level (UNSCEAR 2020/2021 Report) - thoracic region, limbs and joints, mammography and pelvis.

❑ ***The most frequent CT procedures***

- At **national** level (annual national report) -- thorax, head and abdomen region
- At **international** level (UNSCEAR 2020/2021 Report) – head, thorax and abdomen region

- ❖ The UNSCEAR Report highlights the situation prior to the Covid 19 pandemic, the data being collected before it.
- ❖ The distribution of the types of CT procedures in the UNSCEAR report is similar to that in Romania but from 2019, the most frequent procedures being for the head, thorax and abdomen.

Doses received by patients from medical exposures

UNSCEAR 2020/2021 Report: during 2009-2018, approximately 4.2 billion radiological examinations were performed annually, at international level.



collective effective dose of 4.2 million Sv x man for a global population of 7.3 billion people

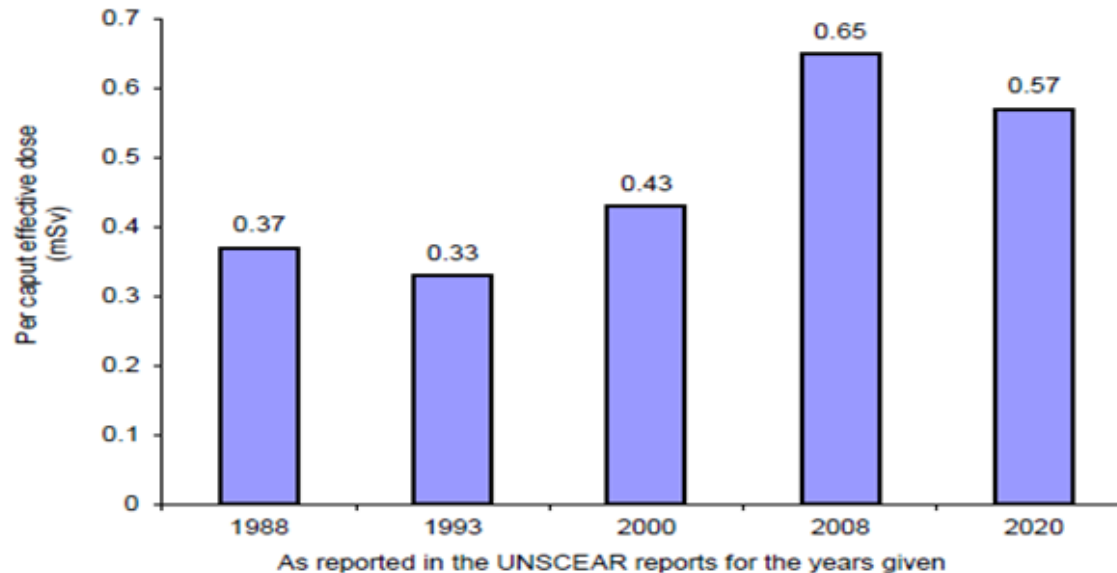


effective dose per inhabitant of **0.57 mSv**, without radiotherapy.

➤ In case of **developed countries**, the effective dose per inhabitant is **1.71 mSv**.

➤ For **România**, the effective dose per inhabitant evaluated in 2021 is **0.75 mSv**,

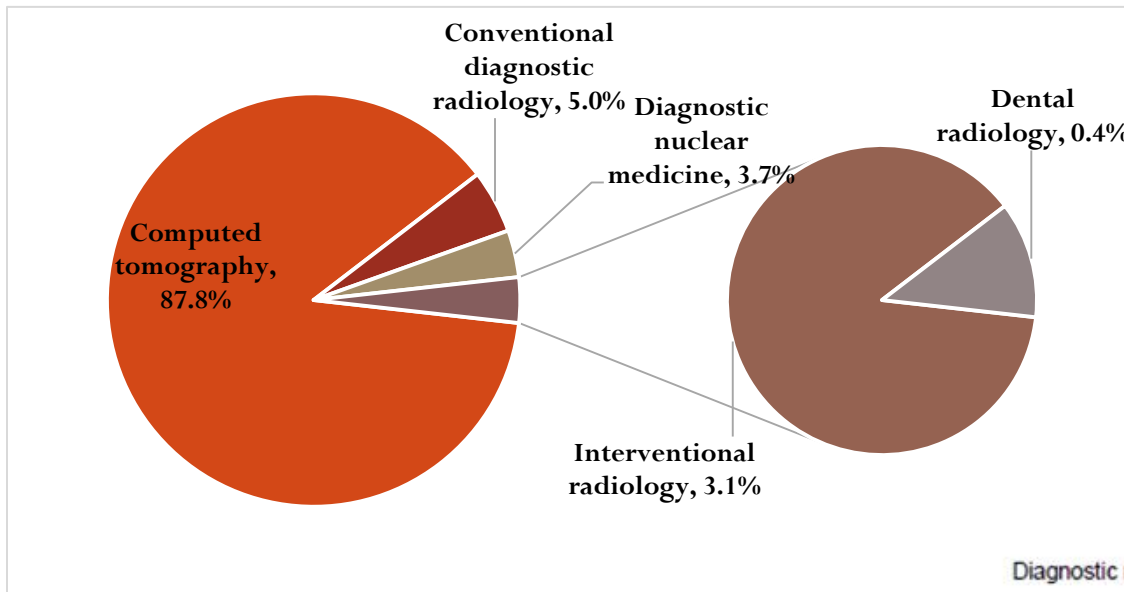
Annual effective dose per caput from different UNSCEAR medical exposure evaluations



According to the UNSCEAR 2020/2021 Report, a decrease in the effective annual dose is noted after almost 30 years in which it was on an increasing trend.

The estimated value for 2020, respectively 0.57 mSv is lower than the one mentioned in the 2008 report, respectively 0.65 mSv, but this is due to the contribution of many developing countries that were included in this new report, countries in which population access to medical imaging procedures is limited and for this reason the collective effective dose is low.

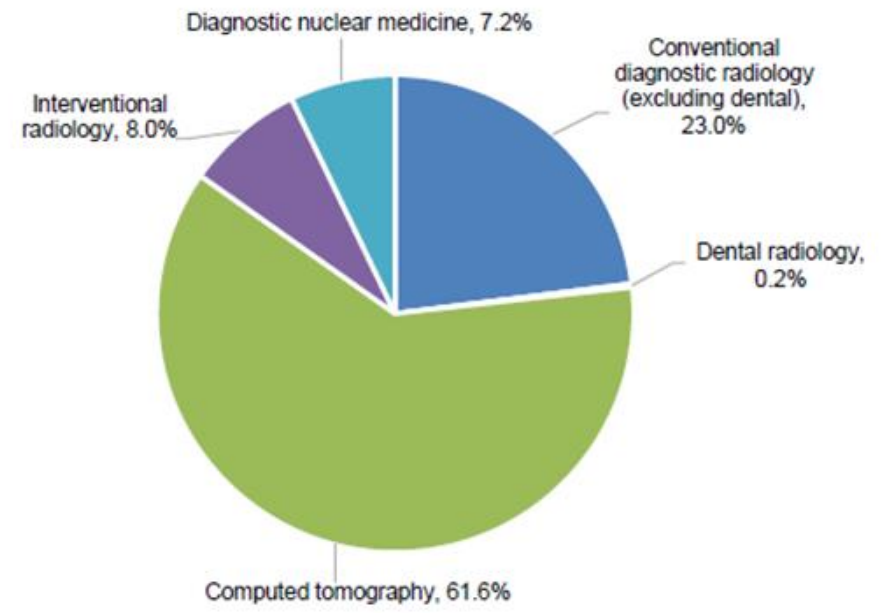
Contributions to the annual collective dose of examinations/diagnostic procedures



international level -- UNSCEAR 2020/2021 Report



national level – National 2021 Report on medical exposures



Typical effective doses per type of examination, according to the 2021 National Report compared to the results of UNSCEAR 2020/2021 Report, for the most frequent conventional radiology and interventional radiology examinations

Examination / procedure type	Typically effective dose (mSv) – UNSCEAR 2020/ 2021 Report	Typically effective dose (mSv) – National 2021Report
Head	0.08	0.06
Cervical Spine (AP + LAT)	0.13	0.07
Lumbar Spine (AP + LAT)	1.0	0.76
Thorax (AP / LAT)	0.08	0.05 (AP) / 0.08 (LAT)
Abdomen	0.61	0.43
Pelvis and hip	0.49	0.44
Mammography(CC + MLO)	0.22	0.28
Ba enema	3.4	1.87
Ba follow through	8.8	6.01
ERCP	4.9	5.36
Urography	1.6	0.68
Cerebral Angiography	6.9	3.61
Cardiac Angiography	7.0	4.04
Abdominal Angiography	8.0	11.5
Pelvic Angiography	7.5	4.93
Peripheral Angiography	3.2	3.76
Dental periapical	0.006	0.002
Dental panoramic	0.024	0.010
CBCT	0.1	0.07

Typical effective doses by type of examination/procedure, according to the 2021 National Report compared to the results of the UNSCEAR 2020/2021 Report, for the most frequent computed tomography and diagnostic nuclear medicine procedures

Examination / procedure type	Typically effective dose (mSv) – UNSCEAR 2020/2021 Report	Typically effective dose (mSv) – National 2021 Report
CT Head	1.9	1.97
CT Cervical Spine	3.1	3.34
CT Throat	2.8	3.84
CT Thoracic Spine	8.0	7.70
CT Lumbar Spine	9.4	11.46
CT Thorax	6.4	5.94
CT Abdomen	11.2	9.22
CT Pelvis	10.9	10.30
CT Trunk	16.7	16.37
CT Limbs	2.1	0.58
PTCA	20.6	13.55
Pacemaker Implantation	1.4	3.44
Abdominal Embolization	32.0	13.60
Peripheral Angioplasty	13.6	9.86
MN Bone Scintigraphy (Tc-99m)	3.6	3.2 (medie) / 4.3 (max)
MN Cardiovascular Scintigraphy (Tc-99m)	6.8	4.9 (medie) / 6.1 (max)
MN Thyroid Scintigraphy (Tc-99m)	3.0	1.7 (medie) / 2.3 (max)
MN Thyroid Scintigraphy (I-131)	24.5	9.5 (medie) / 10.8 (max)
MN Renal Scintigraphy (Tc-99m)	1.1	0.7 (medie) / 0.9 (max)
MN PET CT (F-18)	15.9	16.4

Conclusions and Recommendations

The system implemented in Romania since 2017 and the methodology for recording and centralizing data on the medical exposure of patients are very similar to those adopted by UNSCEAR for the 2020/2021 Report, thus ensuring a confirmation of the correctness of the national system and of a coherent approach, in line with international requirements.

The contribution to the total number of examinations / procedures in Romania, compared to the international average, is:

- 12% lower – for conventional radiology
- 6% higher – for computed tomography
- 6% higher – for dental radiology
- 0.6% lower – for nuclear medicine

The situation in Romania compared to the developed countries.
according to UNSCEAR 2020/2021 Report

examination frequency per 1,000 inhabitants - at the border between the second and third third of the distribution in the UNSCEAR Report.

poor coverage of radiologists at country level (category IV regarding access to radiology services)

the number of radiological equipment is low



more intensive use of resources (doctors / equipment) than in some developed countries (e.g. Sweden), leading to a higher examination frequency compared to these developed countries, in spite of the lower resources

Romania's situation in comparison with all 61 states participating in the UNSCEAR 2020/2021 Report

The **contribution to the annual collective dose** differs strongly at national level compared to the situation presented at international level:

- computed tomography: 88% at national level, respectively 62% at international level
- conventional radiology: 5% at national level, respectively 23% at international level

When speaking about “international level”:

- we refer to an average including many developing countries where the population access to high-performance medical imaging procedures is limited or even very limited,
- we are not referring to the developed countries where the preferred diagnostic procedures are computed tomography and generally high-performance medical imaging and where the contributions to the collective dose are similar to those in Romania

The effective dose per inhabitant in Romania is 0.75 mSv, much lower than in Western countries (1.71 mSv), but above the value of 0.57 mSv considered average at international level

- Average doses per type of examination/procedure at national level are generally comparable and sometimes even lower than typical international doses
BUT
- The examination frequency by CT is higher in Romania, as it also happens in other developed western states

Taking into account this situation, but also the fact that the typical doses are much higher in the case of computed tomography compared to those in conventional radiology, the effective collective doses and thereby the individual doses (per inhabitant) at national level become higher than the international average values.

It is very important:

- to pay special attention to the justification of exposure for each individual patient, especially in case of CT procedures
- to prescribe non-irradiating imaging procedures or conventional radiology instead of computed tomography in all situations in which they are a viable choice
- to optimize the examination protocols, especially in the case of computed tomography procedures, so that the doses received by patients to be as low as possible without affecting the quality of the radiological image necessary to establish a correct diagnosis

The implementation at national level of an IT individual registration system, based on personal identification number, for all examination/procedures performed and for the radiation doses received by patients, would be useful to avoid recurrent exposures

Education and training in radiological protection of the medical staff involved in medical exposures, especially for the awareness of the risk for patients in the case of repetition at short intervals of highly irradiating diagnostic procedures

Bibliography

- “Sources, Effects and Risks of Ionizing Radiation” UNSCEAR 2020/2021 Report, Volume I Report to the General Assembly Scientific Annex A: “Evaluation of medical exposure to ionizing radiation”
- "Report for Health and Environment - 2021", National Program for Monitoring Determinants of the Living and Working Environment, INSP-CNMRMC, 2022 (in Romanian)

***Thank you for
your
attention!***