RAP Conference Proceedings, vol. 9, pp. 36–40, 2024
ISSN 2737-9973 (online) | doi: 10.37392/RapProc.2024.08
RAP-PROCEEDINGS.ORG

# CANCER RISK EVALUATION FOR HIGH-DOSE CHEST CT EXAMINATION DURING THE COVID-19 PANDEMIC

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***Abstract.*** *High-dose chest CT exams were performed significantly more frequently during the Covid-19 pandemic to diagnose and treat patients. While critical for patient care, there are concerns about the potential increase in cancer risk linked with this ionizing radiation exposure. Based on the radiation dose, age, sex, and organ exposure, this study examines the cancer risk linked to high-dose thorax CT during the pandemic in Albania. This study is to evaluate the possible cancer risk associated with high-dose CT exams of the thorax for Covid patients. As a method for calculating the incidence of cancer linked to radiation exposure, the idea of Lifetime Attributable Risk (LAR) is investigated through data collection from Covid 19 patient for the period 2020 -2022. The study's methodology includes a thorough analysis of radiation exposure from CT scans, with a particular emphasis on the risks associated with cancer from thorax imaging techniques. The cancer risks significantly increased linearly with radiation dose of CT scans, with the highest risks for doses greater than 50 mSv. The lifetime attributable risk (LAR) of cancer for adults following CT scans was inordinately increased. This study also investigates how the Covid-19 pandemic has affected the need for and frequency of thoracic CT scans, considering the increasing use of imaging in the diagnosis and monitoring of respiratory diseases during this global health emergency. The results of this study emphasize how crucial it is to weigh the possible long-term hazards of radiation-induced cancer against the diagnostic advantages of high-dose thoracic CT scans. Using the patient's age, sex, and effective dose value, the risk factors from BEIR VII tables for more than 2000 patients, analyzing other complex factors that contribute to the risk of cancer, we found there is a low cancer risk estimation considering as an important factor the age of patients.*

***Keywords:*** *CT scans, high dose, exposure, cancer risk, BEIR VII, effective dose*

## 1. Introduction

The risk of developing cancer from a high-dose chest CT examination during the COVID-19 pandemic depends on several factors, including the individual's age, gender, medical history, and the specific circumstances surrounding the scan. High-dose chest CT scans involve a higher level of radiation compared to standard chest X-rays. While the risk of developing cancer from a single CT scan is generally low, repeated exposure to ionizing radiation over time can increase the risk. However, the benefits of a CT scan in diagnosing and monitoring conditions such as COVID-19-related lung complications may outweigh the potential risks for many patients [1]. In Figure 1 and Figure 2 are given two schematic representations of the situations before and after the Covid 19 pandemic.

Older individuals and those with pre-existing health conditions may be more susceptible to the potential harmful effects of radiation exposure. Conversely, younger, and healthier individuals may have a lower risk. The decision to undergo a high-dose chest CT should be made in consultation with a healthcare provider, considering the individual's overall health and the urgency of the medical situation. In some cases, alternative imaging modalities such as low-dose CT scans or ultrasound may be suitable for evaluating chest conditions with lower radiation exposure. However, these modalities may not provide the same level of detail as a high-dose CT scan, particularly in cases where a comprehensive evaluation of the lungs is necessary [2], [3].

Before undergoing any medical procedure, including high-dose chest CT scans, patients should discuss the potential risks and benefits with their healthcare provider. This includes weighing the necessity of the scan for diagnosing or managing a particular condition against the potential risks of radiation exposure.

Radiology departments and healthcare facilities should adhere to strict radiation safety protocols to minimize the radiation dose delivered during CT scans. This includes using appropriate shielding techniques and optimizing imaging parameters to reduce unnecessary exposure.

In summary, while high-dose chest CT examinations can provide valuable diagnostic information,

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particularly during the COVID-19 pandemic, it's important to consider the potential risks of radiation exposure and weigh them against the benefits of the procedure in each individual case. Collaboration between patients and healthcare providers is essential in making informed decisions about medical imaging procedures [4],[5],[6].

When evaluating the cancer risk associated with high-dose chest CT examinations, several factors come into play:

*Radiation Exposure.* CT scans use X-rays to create detailed images of the body. While these scans are valuable for diagnosing various conditions, they expose patients to ionizing radiation, which can increase the risk of developing cancer, particularly with high doses or frequent exposure.

*Cumulative Dose.* The risk of radiation-induced cancer increases with the cumulative dose of radiation received over time. Therefore, individuals who undergo multiple high-dose CT scans, such as those with chronic health conditions or who require frequent monitoring, may face a higher risk.

*Age and Health Status.* Exposure to ionizing radiation poses a greater danger to children and young people than to adults or the elderly since they are more radiosensitive to it and have longer life expectancies.

*Risk-Benefit Assessment.* The decision to undergo a high-dose chest CT examination should involve a careful evaluation of the potential benefits in diagnosing or monitoring a specific condition compared to the potential risks of radiation exposure. In many cases, the benefits of accurate diagnosis and treatment outweigh the small increase in cancer risk associated with CT scans.

*Alternative Imaging Modalities.* In some situations, alternative imaging modalities with lower radiation doses, such as ultrasound or MRI, may be appropriate for evaluating certain chest conditions. However, these modalities may not always provide the same level of detail as CT scans.

*Radiation Protection Measures.* Radiology departments and healthcare facilities should adhere to strict radiation safety protocols to minimize radiation exposure during CT examinations. This includes optimizing imaging parameters, using appropriate shielding techniques, and employing dose reduction strategies whenever possible.

Overall, while high-dose chest CT examinations play a crucial role in diagnosing and managing various medical conditions, including COVID-19-related lung complications, it's essential to balance the benefits of these scans with the potential risks of radiation exposure. Patients should discuss their concerns and questions about radiation risk with their healthcare providers to make informed decisions about their care [7], [8],[9].

Assessing and comparing radiation dose and cancer risk in thoracic diagnostic and radiotherapy treatment planning CT scans involves several considerations.

By systematically evaluating radiation dose and cancer risk in thoracic diagnostic and radiotherapy treatment planning CT scans, healthcare providers can make informed decisions regarding patient care, balancing the benefits of imaging and treatment with the potential risks of radiation exposure. Ongoing research aims to further refine dosimetry techniques, develop more accurate cancer risk models, and implement dose optimization strategies to enhance patient safety in clinical practice.

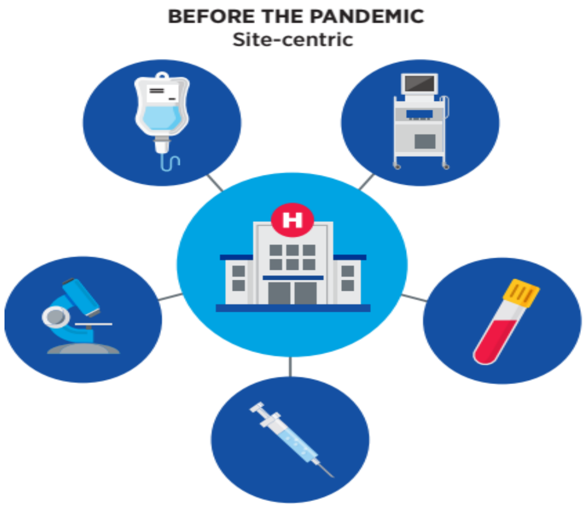


Figure 1. Schematic representation of situation before the Covid 19 pandemic


Figure 2. Schematic representation of situation looking to the future

## 2. Materials and Methods

According to Smith-Bindman et al. (2012), one measure that assesses the connection between exposure and biological effects is the effective dosage. The effective dose idea was put forth by the International Radiation Protection Committee to calculate the potential risk of radiation exposure [3]. The probability of cancer induction and genetic effects resulting from low levels of ionizing radiation pose a stochastic health risk to the entire body. It is calculated as the tissue-weighted sum of the equivalent doses in all designated tissues and organs of the body (The 2007 Recommendations of the International Commission on Radiological Protection, 2007). According to [6],[7], effective dose offers a criterion for comparing modalities in terms of the radiation that is delivered to the patient. In Table 1 are given the information about features of the participants, like age, height, weight, sex etc. In Table 2 is given the risk of developing cancer. In Table 3 is given the risk of dying from cancer.

The two gender groups are tested using two specialized techniques or modalities in computed tomography (CT) imaging, RP-CT (Respiratory Phase Computed Tomography) it used in thoracic imaging, especially for lung cancer or other respiratory-related conditions and DG-CT (Dual-Gated Computed Tomography) it is used in imaging the heart and lungs to minimize motion artifacts caused by breathing and heartbeat.

Table 1. Features of the patients' demographics who took part in this investigation

| | Men | | Women | |
|---|---|---|---|---|
| | RP-CT | DG-CT | RP-CT | DG-CT |
| Age (years) | 61±8.76 | 62±12.48 | 50.44±12.28 | 50.79±17.47 |
| Height (cm) | 168.9±8.07 | 170.2±9.22 | 163±7.46 | 160.1±8.41 |
| Weight (kg) | 71.10±6.75 | 71.6±14.49 | 70.03±10.98 | 71.38±15.15 |
| BMI(kg/$m^2$) | 25.05±4.11 | 24.62±4.32 | 26.35±3.42 | 27.96±6.09 |

Table 2. Risk of developing cancer

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | RP-CT | DG-CT | *Pvalue* | RP-CT | DG-CT | *Pvalue* |
| All cancers | 50.77±14.53 | 34.57±18.91 | 0.059 | 85.46±30.10 | 55.04±31.64 | 0.000 |
| All solid | 42.37±12.81 | 28.79±16.74 | 0.082 | 73.49±26.12 | 50.77±14.53 | 0.000 |
| Leukemia | 9.09±1.67 | 5.77±2.28 | 0.007 | 6.97±1.69 | 4.32±1.26 | 0.000 |

Table 3. Risk of dying from cancer

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | RP-CT | DG-CT | *Pvalue* | RP-CT | DG-CT | *Pvalue* |
| All cancers | 34.44±7.71 | 24.89±14.36 | 0.070 | 52.55±14.34 | 33.13±13.63 | 0.000 |
| All solid | 26.18±6.57 | 19.38±12.94 | 0.028 | 46.49±13.41 | 29.06±12.87 | 0.000 |
| Leukemia | 8.23±1.31 | 4.86±1.53 | 0.000 | 6.05±1.13 | 3.86±1.08 | 0.000 |

### *2.1. CT tools and methods*

A pre-existing thorax HR (High-Resolution) technique that is frequently used to assess patients with suspected idiopathic interstitial pneumonia has been done for suspected COVID-19 patient lungs considering the rapid onset of the pandemic. In contrast to the 3224 exams obtained during the same period in the years of the pandemic Covid 19 only 405 CT Thorax HR examinations were obtained.

Edge scanners were used to carry out the clinical thorax procedure, with 120 kV, 1 mm slice thickness, 1.2 pitch, and 128x0.6 mm collimation.

Using a 110 kV, 1 mm slice thickness, 1.2 pitch, and 16x0.6 mm collimation, a similar process was applied to the Emotion 16. CARE Dose 4D, an automated exposure control system, was activated on all CT scanners with an effective current of 110 mAs.

### *2.2. Calculating the risk of cancer*

Based on organ equivalent doses, the lifetime attributable risks (LARs) of cancer induction were calculated using the Biological Effects of Ionizing Radiations (BEIR) VII study. The leukemia and solid cancer incidence rates per 100,000 participants exposed to 100 mSv are represented by the LAR. Since the BEIR VII model takes a conservative approach and likely overestimates the risk of cancer induction at low doses often used in x-ray diagnostics, it was selected. According to the model, cancer risk behaves like a "linear-no-threshold" (LNT) even at low doses (<100 mSv). For solid tumors, it additionally considers a dose and dose-rate reduction factor (DDREF) of 1.5 [8]-[12].

Additionally, BEIR VII included risk estimates for 100 mSv that could be linearly scaled based on the patient's actual equivalent doses for the organs treated. Thus,

$$LAR = LAR\,100\,(H/100)/10 \qquad (1)$$

might be used to express the relationship between LAR and dosage, where H is the organ-equivalent dose and LAR100 is the BEIR VII risk estimate. After dividing LAR numbers by a factor of 10, the result is the incidence of cancer per 10,000 participants. The data are taken from several hospitals private and publics in Albania.

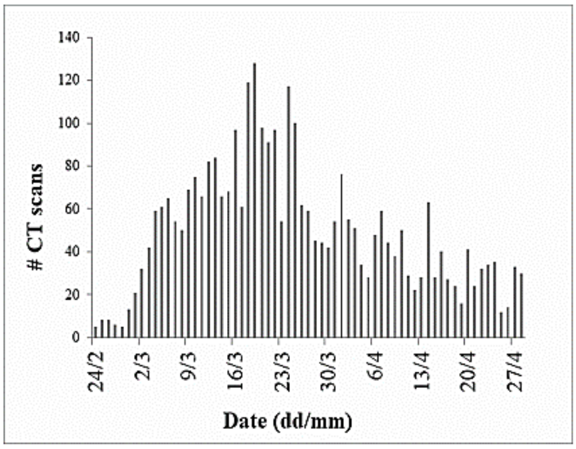


Figure 3. The number of CT scans for suspected COVID-19 during pandemic

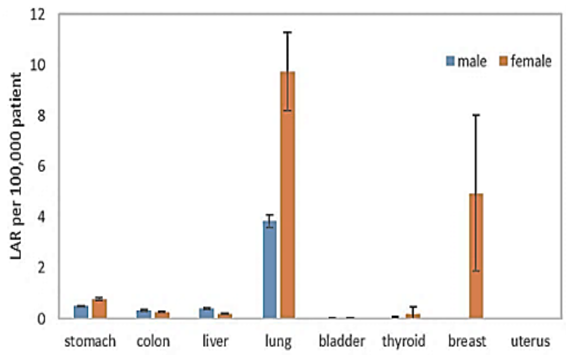


Figure 4. LAR for each cancer in males and females who get a CT scan for COVID-19 diagnosis per 100,000 persons

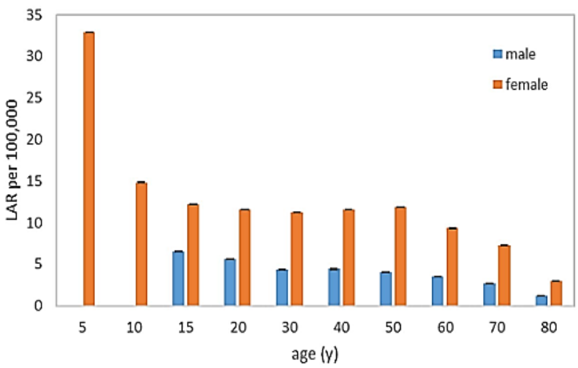


Figure 5. LAR for chest cancer for different ages who get a CT scan for COVID-19 diagnosis per 100,000 persons

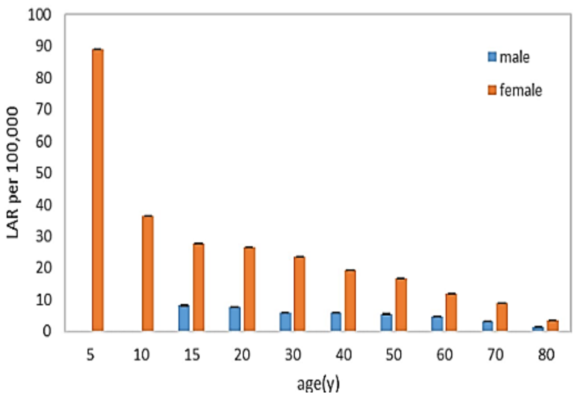


Figure 6. LAR for all cancer types for different ages who get a CT scan for COVID-19 diagnosis per 100,000 persons

Figure 3 presents the number of CT scans for suspected COVID-19 during the pandemic. Figure 4 represents results of LAR (Lifetime Attributable Risk) given for each cancer in males and females who get a CT scan for COVID-19 diagnosis per 100,000 persons. Figure 5 represents results for chest cancer for different ages who get a CT scan for COVID-19 diagnosis per 100,000 persons. In Figure 6 are given the results for all types of cancer cancers for different ages who get a CT scan for COVID-19 diagnosis per 100,000 persons. Males were more likely to get lung cancer, but females were significantly more likely to develop lung and breast tumors, Figure 4. All cancer types had an average LAR of 10.30 per 100,000 patients. For men, it was smaller than for females. As a result, women are at a greater risk than men for lung cancer, Figure 5 and all cancer types in Figure 6.

Females are far more likely than males to get radiation-induced cancer, according to the cancer risk estimations, which showed a significant difference between the sexes. Because of their higher radiation sensitivity, women are more likely to get cancer. The effective dosage and LAR determine this risk. In comparison to men, females had higher BEIR VII report LAR values. Additionally, the findings showed that, in line with other studies females got a larger effective dosage than men.

## 3. Discussion and Conclusion

In the diagnosis and treatment of patients, ionizing radiation imaging procedures are crucial. Because ionizing radiation can cause damage to internal organs, radiation exposure is a major concern during CT imaging treatments. The risk of cancer induction must be evaluated since it is the most well-known side effect connected to the use of ionizing radiation in CT scan imaging. This study is the first to compare the radiation doses from diagnostic CT scans to those from chest CT scans for treatment planning purposes, along with the associated cancer risk. The average effective doses given to patients during thoracic RP-CT scans were 1.5 times higher than those given during thoracic DG-CT scans, according to our study's findings. There was no discernible difference between the two groups' CTDIv. Because RP-CT scans have longer scan lengths than DG-CT scans of the thoracic area, DLP in RP-CT scans was 1.5 times higher.

In comparison to the DG-CT, the LARs of cancer incidence and cancer mortality risk were greater in the RP-CT group. The type of radiation, age of exposure, gender, and the total amount of radiation that the body receives all have an impact on the LAR. Consequently, it is advisable to take patient-specific circumstances into account while figuring out the best radiation exposure parameters, like mA, kVp, and scan length [13], [14],[15].

***Acknowledgements:*** *The authors would like to thank the National Agency for Scientific Research and Innovation (NASRI) in Albania, EFOMP, READ (Research Expertise from Academic Diaspora), ALBMEDTECH and AAMP. Also, we want to thank the Physical Engineering Department.*

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