**Deanship of Graduate Studies**
**Al-Quds University**

# Effective Dose and Cancer Risk Assessment for Adult Patients Undergoing Abdominal-Pelvis CT-Examinations in the West Bank

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**M.Sc. Thesis**

**Jerusalem- Palestine**

**1439/ 2017**

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**A thesis submitted in partial fulfillment of requirements for the degree Master of Public health/ program of Epidemiology/ Faculty of Public Health/Al-Quds University.**

**Jerusalem- Palestine**

**1439/2017**

**Al-Quds University**
**Deanship of Graduate Studies**
**Master Program in Public Health**

## Thesis Approval

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Master thesis submitted and accepted Date: 19 /12 /2017

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Jerusalem
1439/2017

## Dedication

**I dedicate my effort to all whom I love …**

## Declaration:

I certify that this thesis submitted for the degree of Master is the result of my own research, except where otherwise acknowledged, and that this study (or any part of the same) has not been submitted for a higher degree to any other university or Institution.

Wala' Hijazy Solaiman Eneam

Signed: ____________________________

Date: 19/12/2017

## Acknowledgements

I acknowledge my supportive parents (to whom I am very much grateful), family and friends, my thanks and gratitude to my supervisor Dr. Hussein ALMasri for all efforts, encouragements, careful supervision and advices.

Thanks are due to the entire staff of included hospital for allowing and helping me to use their materials and the facility for the progress and achieving of this work.

## Abstract

In Palestine, there are no studies carried out for effective dose (ED) assessment in abdominal-pelvis CT scan and verify whether it carries excessive radiation or not. Excessive dose means more cancer risk or other adverse health effects may be attributed to excessive radiation dose in CT-examinations.

CT scanners are the highest source of radiation that patients are exposed to during the diagnosis of their illness. Abdominal-pelvis CT scanning typically provides an ED of nearly 10 mSv where this value is considered normal worldwide. This dose is equivalent to ~ 400 Posterio-Anterior (PA) chest X-ray radiation dose. Therefore, there is a need to assess the effective dose and lifetime cancer risk values (by using BEIR VII report), during all CT scans in Palestine in order to protect patients' safety.

The main objective of this study is to estimate the radiation effective dose and lifetime cancer risk to adult patients (18-80 years old) undergoing abdominal-pelvis CT in the chosen governmental and private hospitals in the West Bank. A quantitative cohort retrospective design was used to achieve this objective. All adult patients (18– 80 years old) underwent abdominal-pelvis CT examinations in the chosen six governmental and private hospitals in the West Bank. Data collection was through CT-scanner monitors reports issued during two months in the selected hospitals.

Average effective dose was 11.8 ± 5.3 mSv for the total study population ranged between 0.5 mSv and 36.79 mSv. While LAR of cancer risk incidence was 0.082 % (1 in 2116), and LAR of cancer risk Mortality was 0.049 % (1 in 3164) which is considered in low level of cancer risk.

In sectors, average effective dose was 11.45 ± 6.4 mSv for private ranged between 1.77 mSv and 36.79 mSv, and 12.16 ± 4.1 mSv for governmental ranged between 0.5 mSv and 25.2

mSv. Based on hospitals, the highest average EDs values in mSv, were in R.H with (16.41 ± 7.2) mSv, and the lowest one was A.H (7.93 ± 3.7) mSv.

Whereas the highest LAR cancer risk incidence was in R.H with 0.122% (1 in 1187) and the lowest one was A.H 0.050 % (1 in 2602). The highest LAR cancer risk Mortality was in R.H with 0.071% (1 in 1856), and the lowest one was A.H 0.031% (1 in 4061).

Average effective dose for adult patients who underwent abdominal-pelvis CT examinations in this work was in acceptable level. LAR of cancer risk Incidence and Mortality were all in low level.

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## List of Abbreviations and Units

| Abbreviation | Meaning |
|---|---|
| CT | Computed tomography |
| ED | Effective Dose |
| PA | Posterio-Anterior |
| BEIR | Biological Effects of Ionizing Radiations |
| LAR | Lifetime Attributable Risk |
| P.A.H | Princess Alia Hospital |
| J.G.H | Jeneen Governmental Hospital |
| P.M.C | Palestine Medical Complex |
| A.H | AL-Ahli Hospital |
| A.I.H | Arab Istishari Hospital |
| R.H | AL-Razi Hospital |
| U.S | United States |
| DRLs | Diagnostic Reference Levels |
| DNA | DeoxyriboNucleic Acid |
| ICRP | International Commission on Radiological Protection |
| mSv | Millisievert |
| NAS | National Academy of Science |
| MRI | Magnetic Resonance Imaging |

| | |
|---|---|
| U/S | Ultrasound |
| UK | United Kingdome |
| MOH | Ministry Of Health |
| FDA | Food and Drug administration |
| ACR | American College of Radiology |
| mGy | milliGray |
| L.S.S | Lumpo-Sacral Spine |
| K | Global Coefficient for abdominal CT |
| NCRP | National Council on Radiation Protection |
| ACR | American College of Radiology |
| L.S.S CT | Lumpo-Sacral Spine Computed Tomography |
| AED | Annual Effective Dose |
| NRPB | National Radiological Protection Board |
| KVp | Killo-Voltage peak |
| MAs | milliAmpiresecond |
| T | Slice thickness |
| CTDIv | Computed tomography Dose Index volume |
| DLP | Dose Length Product |
| LAR Inc % | Lifetime Attributable Risk Incidence Percentage |
| LAR Mor % | Lifetime Attributable Risk Mortality Percentage |

| | |
|---|---|
| CTDIw | Computed tomography Dose Index weighted |
| mA | milliAmpere |
| P | Pitch Ratio |
| LSS | Life-Span Study |
| FOV | Field Of view |
| FAD | Focal Axial Distance |
| ALARA | ‘‘As Low As Reasonably Achievable’’ |
| ACRDR | The American College of Radiology Dose Reference |
| ACR AAPM | The American College of Radiology and the American Association of Physicists in Medicine |
| EU | European Union |

# Chapter One

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## Introduction

This chapter gives the background, problem statement, justification, study aim and objectives, hypothesis and research question.

### 1.1 Historical Background

X-ray is a high energy electromagnetic radiation. It was discovered by William Rontgen in 1895. It consists of ionizing x-ray photons, which can penetrate human body to provide images, and can often be used instead of surgery, which was used previously for medical diagnosis, while diagnostic surgery was associated with a lot of pain and risks for patient. X-ray machines are in widely used and developing continuously.

Computed tomography (CT) imaging was invented in 1970's. It consists of a rotating X-ray tube and detectors combined with a computer to process and produce a cross-sectional and three dimensional images of all body tissues quickly. It produces a high quality and resolution CT-images, and has the ability to cover a large area of the patient's body. CT imaging can take accurate images of heart and blood vessels, small and large tumors (can determine the presence, location, and size accurately) (Muhogora et al., 2009).

The number of scanners is dramatically increasing with continuous and wide improvements in quality, accuracy, speed and resolution. Therefore, the number of CT examinations has increased to reach millions of CT exams yearly worldwide, which means increasing the amount of ionizing radiation (i.e. increasing patient absorbed dose and total population dose).

CT-Scan is considered to be the highest contributor to the total population dose, with more than 60 million CT-scans obtained in U.S. annually (Martin and Semelka, 2006). In 2006, CT was responsible for 70% of medical radiation exposure (Martin and Semelka, 2006), CT-dose has a potential future or lifetime cancer risks, since ionizing X-ray beam can cause DNA damaging and mutations of cells, which then may grow to form tumors (Storrs, 2017). Therefore, dose from CT examinations became a global public health issue.

The potential radiation effects and risks on human body are attributed to the absorbed dose levels in CT examinations. Diagnostic Reference Levels (DRLs) and specific European Guidelines on quality criteria were established and distributed globally for CT-procedures dose optimization and assessment (International Atomic Energy Agency, 2013). These guidelines aimed to insure that all CT doses are within the acceptable ranges for each examination which allows estimating the possibility of stochastic and deterministic effects of radiation exposure. Any increase in the absorbed dose will increase the potential changes in cells growth and DNA composition (cancer risk) by ionizing radiation. The effective Dose (ED: describe the amount of radiation received, the magnitude of ED is related to the stochastic radiation risks of cancer induction and the production of genetic effects) (ICRP, 1990; ICRP, 1977), is the mostly used and preferred as a CT-dose descriptor, and for radiation quantization and determination of the potential risks.

Recently, both public and governmental health sectors have realized that the radiation exposure from CT is a public health issue. There is a great interest worldwide from researchers on this issue. Epidemiological studies focus on the relationship between patient's absorbed dose and cancer risk.

In this study, radiation doses to patients, from routine abdominal and pelvis CT procedures, will be estimated using equations. The aim is to determine radiation effective dose received by adult patients with ages ranging from 18 to 80 years, in order to protect patients undergoing CT-examinations from excessive radiation absorbed dose, and to serve as a dose guideline to provide more awareness about CT-overdose for radiologist and radiographers and other related medical staff.

## 1.2 Problem statement

Computerized Tomography (CT) became a highly requested procedure in medical imaging departments because of its ability to provide high detailed fast images. In radiation protection, the risk of adverse health effects is proportional to the amount of radiation-absorbed dose, as previously mentioned. The amount of dose depends on the type of medical imaging modality and amount of X-ray in the examination. Abdomen and pelvis CT has an adult's approximate effective radiation dose (ED) of 10 millisievert (mSv); which is a measurement of the energy absorbed by body tissues (RI.org, 2016). This is equivalent to ~400 Posterio-Anterior (PA) chest X-ray in comparison to natural background radiation for three years (RI.org, 2016). However, any increase in this average will be associated with an increase in the possibility of fatal cancer in the future.

In 2005, National Academy of Science report showed that one patient in 1000 develops cancer from exposure to a 10 mSv dose of radiation (NAS, 2005). Lack of awareness among physicians, radiologist, radiographers, and patients is causing an increase in the lifetime cancer risk.

Any small increase in the effective dose will increase cancer risk probability. This is a worldwide public health concern nowadays. Large numbers of population undergo CT scans daily. This encourages further epidemiological studies and researches in this field.

Whereas, ionizing radiation exposure from medical imaging examinations for diagnosis has an adverse health effects divide to deterministic health effects because of cell death or damage by ionizing radiation dose as hair loss and erthema. There are also stochastic health effects, such as lifetime cancer risk because of mutations (Schmidt, Hupfer, Saltybaeva, Kolditz &

Kalender, 2017). ED is not a measurement, but instead of that it reflects the stochastic risk such as cancer induction due to ionizing radiation exposure. EDs facilitates biological effects comparisons between different types of medical diagnostic procedures to be used in a mathematical model for lifetime cancer risk incidence and mortality calculations (McCollough et al., 2009).

Risks of radiation exposure depend on the value of the effective dose, type of the examination and the quantity of radiation that the patient receives, in addition to the age and sex. The BEIR VII report (which depending on patient age and sex), was used for EDs and LAR cancer risk assessment as shown in Table 1.1(The BEIR VII (2006) report, 2006).

Table 1.1: Approximate lifetime fatal cancer risk for patients from examinations.

| **Risk level** | **Approximate lifetime fatal cancer risk for adult patients from examinations** |
|---|---|
| Negligible | less than 1 in 1 000 000 |
| Minimal | 1 in 1 000 000 to 1 in 100 000 |
| Very Low | 1 in 100 000 to 1 in 10 000 |
| Low | 1 in 10 000 to 1 in 1 000 |
| Moderate | 1 in 1 000 to 1 in 500 |

## 1.3 Justification

Availability of radiation doses to patients during CT, allows comparison to be made of the hazards in CT-scans with alternative diagnostic examinations, which also use ionizing X-ray radiation to obtain images. Additionally, CT-radiation doses can be used to optimize CT protocols with respect to the radiation risk for the patient. Different national surveys proved that CT is the largest source of radiation exposure and provides huge percentage of the collective dose from medical radiation exposure, nearly 35% in Germany (Kaul et al., 1997), and 47% in the UK (Hart and Wall., 2004).

Calculating effective dose helps to improve patient safety in CT-examinations. So EDs estimation can be used to assess radiation doses received and to make effective dose comparisons between different scanners to check for any differences between different and identical scanners. This will help to determine whether such CT radiation doses to patients are as low as reasonably achievable (ALARA principle)(Uffmann and Schaefer-Prokop, 2009), as required by the International Commission on Radiological Protection (ICRP).

One study reported that CT scans performed in the U.S. in 2007 will result in 29,000 new cancer cases and roughly 15,000 deaths that would not have occurred if CT-scan was not preformed (Berrington et al., 2009). These risks would increase with each additional CT scan a person receives.

The importance of this study comes from being the first in assessing the average CT radiation doses for adult patients with ages ranging from 18-80 years undergoing routine abdominal-pelvis CT. The ED will be used to assess radiation exposure amount and lifetime cancer risk incidence and mortality for those patients. While there is a global trends globally towards trying to decrease the number of CT scans, in Palestine CT examinations were increasing rapidly from 42,818 in 2013 (MOH, 2013), to 70,599 in 2014 (MOH, 2014) and 88,191 in 2015 (MOH, 2015).

## 1.4 Study Goal

To estimate the radiation effective dose and lifetime cancer risk to adult patients (18-80 years old) undergoing abdominal-pelvis CT in governmental and private hospitals in the West Bank.

## 1.5 Study Objectives

### 1.5.1. General objective:

To estimate the effective dose and lifetime cancer risk of abdominal-pelvis CT for adult patients (ranging from 18 to 80 years).

### 1.5.2. Specific objectives:

1. To record frequency of abdominal-pelvis CT examinations during study period.
2. To assess collective average effective dose from abdominal-pelvis CT per hospital.
3. To assess collective effective doses contribution of each scanner to the total collective effective doses from CT-procedures.
4. To compare total effective dose between different and identical CT scanner models.
5. To develop criteria for determining the limits that are clinically acceptable and to determine which models are more suitable and acceptable for clinical use to improve patient's safety and protection.
6. To increase the awareness of medical staff (radiologist, radiographer and physicians) regarding high dose risk of cancer probability in abdominal-pelvis CT generally, and more specifically on colon.

## 1.6 Study Hypothesis

The differences between average effective doses (EDs) evaluated in Palestine and internationally used will be within acceptable limits.

## 1.7 Research Question

- Are the average effective doses (EDs) within acceptable limits and are they safe as compared to international ones?

# Chapter Two

## Literature Review

This chapter reviews some literature, published studies and researches on CT-dose assessment and related risk, and display different methodologies that were used to determine dose and related cancer risk assessment.

## 2.1 Introduction

In an article entitled (Computed Tomography (CT) Scans and Cancer), from National Cancer Institute, the author concluded that ionizing radiation exposure increase the risk of cancer from CT-Examinations more than that from other conventional X-ray examination such as, routine X-ray and mammography, which use very low levels of ionizing radiation, compared with that from CT exposure. However, sometimes having CT is much more useful than the conventional X-ray, especially if it is used for cancer diagnosis or other serious conditions (Cancer.gov, 2013).

Commonly, the extra risk to develop a fatal cancer from CT examination is nearly 1 per 2000 (U.S FDA., 2009). While the risk of death from cancer among the U.S population normally is nearly 1 per 5 (Howlader et al., 2013). In the same article, the author concluded that global use of CT and other diagnostic procedures that use ionizing radiation to provide images of patient's body, has increased the risk in getting cancers, and that could lead to huge numbers of cancer cases in the future (Berrington et al., 2009; Smith-Bindman et al., 2009).

In a study that aims at assessing the awareness among patients who had abdominal or flank pain and who underwent CT-examination in Emergency Department, about the benefits and risks of CT-dose and if that had been interpreted previously, and also they were then asked to estimate CT-dose compared to radiation dose from plain chest X-ray. Emergency doctors (who often request CT-examinations), and radiologists (who write and interpret CT-scans) are included in the survey of the previous study (Lee et al., 2004).

In the same study, only 3% of patients and 9% of emergency doctors had the knowledge that CT-dose raised cancer-lifetime risk. Surprisingly, only 47% of radiologists in the survey provide the correct answer for radiation cancer risk. In radiation dose estimation of CT compared with plain chest X-ray, mostly, they believed CT provided radiation dose ranging from 2 to 10 times of that in chest X-ray. Unexpectedly, 64% of patients, 44% of eemergency doctors, and 56% of radiologists chose this answer from five options.

However, in reality, CT-dose is nearly 100-250 times more than a chest X-ray dose. Only 22% of the emergency doctors and 13% of radiologists provided a right answer (none of the patients knew that it is high). Patients were not educated about this issue. Since 78% of the emergency doctors said that, they had not mentioned or interpreted CT examination risks and benefits to patients. Around (93%) of patients answered that CT scans' risks and benefits had not been informed to them previously (Lee et al., 2004).

American College of Radiology (ACR) has also developed and facilitated the (Dose Index Registry) which contains information related to dose provisions for all CT examinations at all participating centers and hospitals. The data in the registry are then used to compare CT dose indicators in those centers and hospitals and to produce national benchmarks. Finally, it was mentioned that CT manufacturers are developing newer systems that can produce images higher in quality by using much lower X-ray radiation dose (acr.org, 2013).

## 2.2 Previous studies

### 2.2.1. Local and regional studies:

There are few studies in Palestine pertaining to the CT effective dose for patients in hospitals with CT scanners and its role in causing cancer. However, there is a non made on abdominal-pelvis CT-scan protocols.

In a very recent local study entitled “Breast Radiation Doses and Cancer Risk from Female Chest Scans in Palestine”, author mentioned that there are nearly 28 scanners in Palestine, 24 scanners in West Bank, and only 4 scanners in Gaza Strip. Study included 10 Palestinian hospitals in Palestine (200 female patients underwent chest X-ray in these hospitals).

For the total study population, the mean ED was 7 mSv, values ranged between 3 to 14.7 mSv, the mean ED for breast was 15 mSv and ranged between 6.5 and 17.5 mSv.

The Lifetime attributable breast cancer risk was also estimated to be 0.00014 % in younger female or 1 in 2645 for 15-39 years, and 0.00014 % in older female or 1 in 10473 for 40 to 60 years. While ICRP dose shouldn’t exceed 45 mGy, and LAR of breast cancer for younger and older female patients shouldn’t be higher than 0.00865% and 0.00160 % respectively. Author found that ED to glandular breast tissue declines with using suitable exposure scanning parameters (Kameel, 2017).

### 2.2.2. International studies:

Many epidemiological studies were carried out globally and focused on identifying, assessing and controlling the radiation absorbed doses. Those studies estimated effective dose of CT examinations and its contribution in each examination.

In a study, (Trends in examination frequency and collective effective doses from computed tomography (CT) procedures in Sudan), abdomen CT accounted for the highest number of population. Number of patients who underwent abdominal CT were 457 patients; with an average effective dose of 7.01 mSv ranging (1-24.4 mSv). While patients who underwent pelvis CT were, only 30 patients had an average ED of 4.82 mSv ranging from 1.44-11.23. In Chest CT, 263 patients with an average ED of 4.45 mSv ranges (1.28-11.45), then head CT with 118 patients had an average ED of 2.04 mSv ranging (0.2-4.41), and neck CT with only 21 patients with an average ED of 2.58 mSv ranging (1.27-4.96) (Elameen, 2010).

In the same study, it can be noted that abdomen CT occupied the highest ED with 32% in percentage. The author attributed that to the high ED per examination resulted from abdomen CT, while abdomen, Lumbo-Sacral Spine (L.S.S), and pelvis CT were equal in ED per examination (6.6 mSv), then head with 5.3 mSv, and chest 4.6 mSv. ED dose for abdomen CT was within acceptable range in this study.

The study also showed comparisons of EDs per examination for Norway, UK, and Sudan, where abdomen CT ED were 12.8, 10, 6.6 mSv, and for L.S.S CT were 4.5, 8, 6.6 mSv, while for head were 2, 2, 1.6 mSv, respectively. Therefore, we notice that abdomen occupied the highest ED level in all countries and examinations with slight differences (Elameen, 2010).

In another article entitled (An estimation of the annual effective dose (AED) to the Canadian population from medical CT examinations), results showed that the ED from CT-examinations was 0.74 mSv in 2006, while in 1991, it was only 0.19 mSv. This marked increase in CT-dose was attributed to the introduction of the multi-detector CT-scanners where CT examinations rate and higher dose for each examination were doubled (Chen and Moir, 2010).

This study also showed that percentage of patients receiving repeated abdominal CT scans was 70 % with an annual effective dose (AED) of 10 mSv. Single repeat percentage for abdominal CT was 17.6% with AED of 30 mSv. It was finally concluded that for three or more repeated times, the percentage was 5.7% with AED of more than 40 mSv. This is equivalent to nearly 129 years of cosmic rays exposure, or to 35 years of the average radon exposure concentration in Canadian houses.

In an article entitled (Optimization of patient Dose in Abdominal Computerized Tomography), CT-dose optimizations was achieved by CT- scan protocol and improvement of the referring criteria.

Software from National Radiological Protection Board (NRPB) was employed for EDs estimation. Mean age of patients was 45.4 ±18 years, average ED was 13.5 before the CT-dose optimization, and reduced to be 4.3 mSv after optimization. Therefore, dose optimization protocol in this study successfully decreased the average ED to 31.9 % (Elnour and Sulieman, 2011).

In another article entitled "Radiation Effective Doses to patients undergoing abdominal CT examinations", mean values of patient ED were 6.1 mSv ± 1.4 for children (included 31 patients aged 10 years and less), 4.4 mSv ± 1.0 for young adults (included 32 aged 11-18 years), and 3.9 mSv ± 1.1for adult patients (included 36 patients older than 18 years).

The author also showed that energy imparted values to patients undergoing abdomen CT-scan had a factor of three times more in adult patients than in children, but the corresponding patient EDs were 50 % much more in children than in adult patients (Dan et al., 1999).

In a retrospective cross-sectional study entitled (Radiation Dose Associated with Common Computed Tomography Examinations and the Associated Lifetime Attributable Risk of Cancer), aimed to describe the radiation dose and to assess the lifetime attributable cancer risks by these doses measurements in the 11 most popular CT examinations, was performed on 1119 consecutive adult patients during 5 months in 2008.

There was a significant variation between different CT examinations, the average ED for head CT was 2.1 mSv, ranged between 1.8 and 2.8 mSv, the average ED for a multiphase abdomen and pelvis CT was 31 mSv, ranged between 21 and 43 mSv.

While LAR cancer incidence between patients who underwent a coronary angiography CT at age 40 from that procedure was (1 in 270 women), (1 in 600 men), in comparison with routine head CT LAR of cancer incidence was (1 in 8,100 women at the same age) and (1 in 11, 080 men). While for 20years old patients, the LAR cancer risks were nearly doubled, and for 60 years old patients the LAR cancer risks nearly 50% lower.

Authors described the necessity for more standardization between institutions, and requested to be sure for the need of CT scan, especially for younger female, in addition to balance CT benefits and risks for those patients before perform such examinations **(**Smith-Bindman, 2009).

# Chapter Three

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# Theoretical Background

This chapter contains all variables, processes, and outcomes of this study.

### 3.1Conceptual framework

This study aims to assess the radiation effective dose and lifetime cancer risk to adult patients (18-80 years old) undergoing abdominal and pelvis CT in governmental and private hospitals in the West Bank, ED will be used as a dose estimator or descriptor.

#### 3.1.1. Independent Variables:

Independent Variables of this study include:

1. **Patient's examination data:**

   Include Kilo-Voltage peak (kVp), milliAmpere-seconds (mAs), slice thickness (T), Dose Length Product (DLP), CT dose index volume (CTDIv).

2. **Socio-demographic factors:**

- Gender (Male / Female).
- Age (18-80 years).

#### 3.1.2. Dependent Variables :

Dependent Variables (outcomes) of this study include:

1. Average ED at each hospital.
2. Lifetime cancer risk incidence (LAR Inc %).
3. Lifetime cancer risk mortality (LAR Mor %).

## 3.2 CT dose

Effective dose estimation in CT basically depends on radiation exposure factors that include kVp , mAs, CTDIv, DLP, and Pitch values.

### 3.2.1. Kilo-Voltage peak (kVp):

It is the X-ray photons energy. kVp value directly proportion with radiation absorbed dose during CT examination, which means increasing in effective dose value.

### 3.2.2. milliAmpere-seconds (mAs):

Is the x-ray tube current milliAmpere (mA) per scan time (s), which is represented the amount of radiation X-ray photons per second, the relationship between mAs and patient absorbed dose is that 50% reduction of mAs value will be associated with 50% reduction of the radiation dose.

**milliAmpere-seconds (mAs) = tube current(mA) X exposure time (s) ………………..…(1)**

### 3.2.3. Pitch Ratio (P):

Estimate by the table movement (increment distance) per on full rotation of the X-ray tube divided by the width of the X-ray beam. There is a reverse relationship between the Pitch value and the patient dose, so increase pitch leads to decrease patient dose, and vice versa.

### 3.2.4. Computed Tomography Dose Index volume (CTDIv):

CTDIv measured in milliGray (mGy), is an estimation of the average dose during the CT scan volume to a standardized phantom.

Total amount of delivered radiation to a standardized phantom is equal Dose Length Product (DLP) value, which is represented by CTDIv and scan length. CTDIv is introduced to estimate the radiation dose in multi-detector scanner and permits different values in exposure in Z-axis direction when the pitch is above 1 for one rotation of X-ray tube.

### 3.2.5. Dose Length Product (DLP):

It is used in the effective dose estimation for slices series or whole procedure. In some of CT scanners, the DLP and CTDIv values appear for each CT examinations.

DLP represents the whole energy amount that is delivered by a given CT examination, which represents in equation number 1:

**DLP (mGy.cm) = CTDIv (mGy) X Scan Length (cm)…………………………………… (2)**

DLP depends on the converge imaged area length of the patient body during CT scan, so that means any increase in DLP directly means increase in the effective dose value.

# Chapter Four

# Methodology

This chapter provides experimental framework of the study, from data collection, to the calculations of effective dose and assessment of lifetime cancer risk, data analysis and comparison.

## 4.1 Introduction

This study aims to assess the value of the effective dose and the lifetime attributable risk (LAR) of cancer incidence and cancer mortality from abdominal-pelvis CT-examinations protocols. Required data was taken from CT scan registries in all radiological departments in the chosen governmental and private hospitals in West Bank. Abdominal-pelvis CT scans carried out within two months period were collected.

## 4.2 Settings

The study was conducted at chosen governmental and private hospitals that have CT-unit in the West Bank. Governmental hospitals include (Jenin Governmental Hospital, Princess Alia Hospital, Palestine Medical Complex), which provide health services free or semi-free (health insurance), so they have the largest load on CT-examinations, and has become the main source of abdominal-pelvis CT examinations when compared with other private or chargeable hospitals. We also included private hospitals which have the largest load on CT-examinations; (AL-Razi Hospital, Arab Istishari Hospital, AL-Ahli Hospital). Results are used to compare the results between the two sectors (governmental and private), and to investigate reasons for the differences in ED, and to estimate lifetime cancer risk, if any.

### 4.3 Research design

Quantitative retrospective cohort study was chosen to fulfill the aim of the study. Data was obtained from two months records before the beginning of data collection from included radiological departments of the chosen governmental and private hospitals in the West Bank.

### 4.4 Study Population

Study population includes all adult patients with ages ranging from 18 to 80 years, undergoing routine abdominal-pelvis CT examinations in the West Bank.

### 4.5 Study Sample

Multistage sampling methodology was adopted. The West Bank is divided into three regions (First Stage) which are; northern region (Tulkarem, Qalqylia, Jenin, Nablus, Tubas and Salfit), middle region (Jerusalem, Ramallah and Jericho) and southern region (Hebron and Bethlehem).

Two major hospitals were selected in each region (One governmental and one private) which represents the second stage. Then, all adult patient files that are in the inclusion criteria and undergone routine abdominal and pelvis CT examinations, between Novembers to December 2016 in the selected hospitals, were included in the study.

- **Northern region:**
- Jenin Governmental Hospital and AL-Razi Private Hospital.

- **Middle region:**
  - Palestine Medical Complex (Governmental hospital) and Arab Istishari private Hospital.

- **Southern region:**
  - Hebron Governmental Hospital and AL-Ahli Private Hospital (Patient’s friends society).

#### 4.5.1. Inclusion criteria:

All adult patients ranging from 18 to 80 years who underwent routine abdominal-pelvis CT examinations in the chosen governmental and private hospitals in the West Bank, during two months between Novembers to December 2016, were included.

#### 4.5.2. Exclusion criteria:

Patients with gross abnormalities and those who will need procedures involving special details or additional body parts were excluded.

### 4.6 Study tool

Study tool used to assess effective dose and lifetime cancer risk contained two parts:

#### 4.6.1. Patient's file:

Data about Patient’s age and sex, slice thickness, filter type, and DLP, CTDIv and/or CTDIw, were extracted from patients file for each participant in the study.

#### 4.6.2. Global equations:

Global equations were used for radiation dose and lifetime cancer risk assessment. Equations were used as dosimeter tool for quantifying CT doses, and improving patient protection (reduce any attributed risk of overdose).

This study is directed to radiologists, radiographers, medical physicists, CT scanner manufacturers and related medical researchers. It permits radiation professionals to take very accurate CT images with much more patient safety from any associated risks of overdose.

#### 4.6.3. The BEIR VII report:

The most current and recent model for cancer risk assessment and other health risks from low level ionizing radiation exposure. It is the first model of its kind that provide detailed estimation of lifetime cancer risk incidence and mortality, basically this report for cancer risk assessment depends on epidemiological studies, and on the population from Hiroshima and Nagasaki in 1950, whom were residents, popular as the life span study (LSS).

This report can estimate cancer risk for leukemia and other non-leukemia cancers. The radiogenic cancer risk is related to the age and sex of exposed patient and radiation linear energy transfer. The latency periods by this report were ten years for other leukemia cancers, and two years for leukemia.

### 4.7 Data collection

Data were collected by using a work sheet for all adult patients who underwent abdominal-pelvis CT in the included hospitals during study period to insure the consistency of the data (APPENDIX A and B). This stage was performed in three main steps:

### 4.7.1. Patient's data collection:

Patient's data and factors used for ED and LAR assessment include Patient's sex, age, kVp, mAs, slice thickness, scanning length, and CTDIw and/or CTDIv. Data was filled in specified self-designed worksheets, for more accuracy and consistency.

### 4.7.2. Comparison between CT-scanners:

Six CT-scanners were included to estimate EDs and LAR during this study. These scanners are installed in six private and governmental hospitals radiological departments. Table 6.9 shows six CT scanners specifications in West Bank.

Table 4.1: Specifications of CT scanners that used in included hospitals.

| Hospital | Sector | Manufacturer/ Installation year | Scanner Model |
|---|---|---|---|
| **P.A.H** | Governmental | Philips Medical systems, 2010. | 16 slices, |
| **J.G.H** | Governmental | GE Medical systems, 2008. | 4 slices, |
| **P.M.C** | Governmental | Philips Medical systems, 2010. | 64 slices |
| **A.I.H** | Private | Philips Medical systems, 2014. | 128 slices |
| **A.H** | Private | GE Medical systems, 2014. | 128 slices |
| **R.H** | Private | Philips Medical systems, 2016. | 128 slices, |

#### 4.7.3. Distribution of abdominal-pelvis CT scans:

##### 4.7.3.1 Distribution of abdominal-pelvis CT scans per sector:

Total study population was distributed in two sectors (private and governmental), each consisted of three hospitals, total patient number in both sectors was 435, since private sector included 217 adult patients (50%), and governmental sector included 218 adult patients (also 50%), which are shown in Figure 4.1.

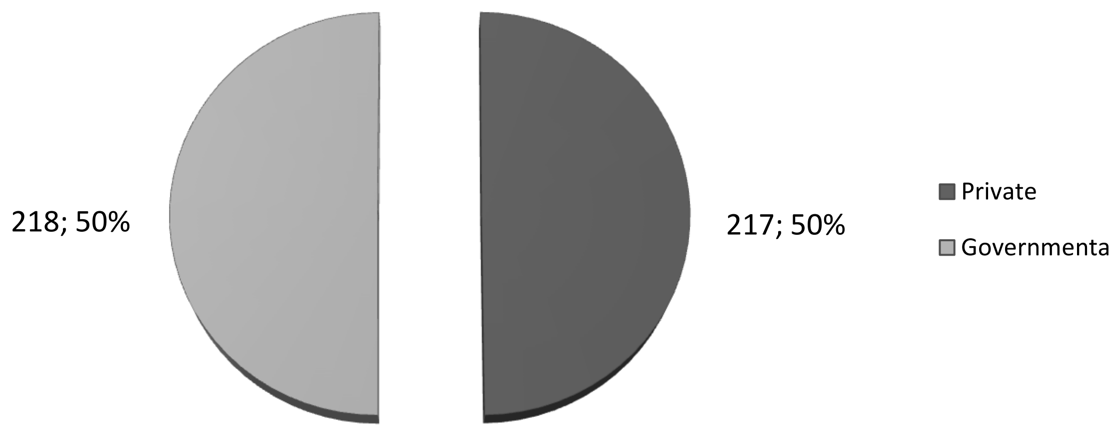


Figure 4.1: Frequency of abdominal and pelvis CT-examinations per sector.

##### 4.7.3.2. Distribution of abdominal-pelvis CT scans per hospital:

The distribution of abdominal-pelvis CT examinations, which were performed at included hospitals for the period of study, is shown in Figure 5.5. ED and LAR assessment were performed for adult patients (18-80).

A total number of 435 adult abdominal-pelvis CT examinations were recorded from the CT-unit. Out of them, 230 (53%) were males and 205 (47%) were females they underwent abdominal and pelvis CT-scans in six hospitals, the highest being in Princess Alia Hospital (P.A.H) with 156 patients (36%) followed by AL-Ahli hospital (A.H) 104 (24%) and Arab Istshari Hospital (A.I.H) 90 (21%), Jenin Governmental Hospital (J.G.H) 51 (12%), AL-Razi Hospital (R.H) 23 (5%), and the lowest was Palestine Complex (P.M.C) 11(2%), as shown in Figure 4.2.

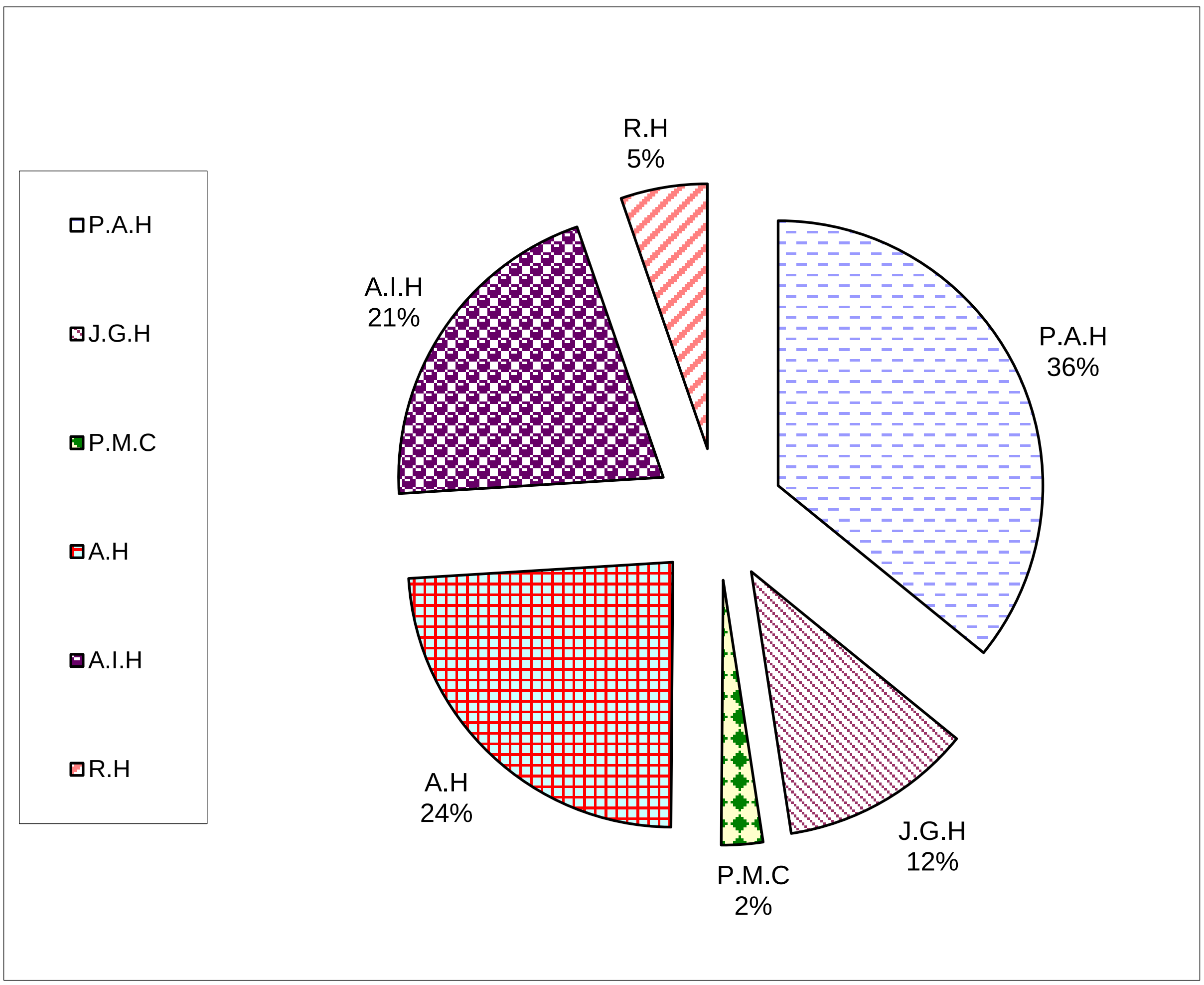


Figure 4.2: Frequency of abdominal-pelvis CT examinations per hospital.

#### 4.7.4. EDs and LAR of cancer assessment and data comparisons:

Data comparison contained three parts.

##### 4.7.4.1. Effective dose assessment:

ED was estimated by DLP and appropriate normalized coefficients (K) that can be found in the European Guidelines on Quality Criteria for CT Report 16262, for abdominal-pelvis CT equal 0.015 mSv/mGy.cm (European Commission (EUR) Report 16262, 1995).

**ED = K * DLP ……………………...………………………………………………….… (3)**

##### 4.7.4.2. The lifetime attributable risk (LAR) of cancer:

After ED assessment for patients, LAR of cancer incidence and cancer mortality are calculated by the following equations respectively with depending on tables that display LAR of cancer Incidence and Mortality for adults male and female at age of exposure (APPENDIX C and D) (The BEIR VII (2006) report, 2006)**:**

$$\textbf{LAR of Cancer Incidence\%} = \left[\frac{\mathrm{ED(mSv)}}{100}\ \mathrm{X}\ \frac{\mathrm{LAR\ (Cancer\ Incidence)}}{100000}\right]\mathrm{X}100 \quad \text{……..………..……} \quad (4)$$

$$\textbf{LAR of Cancer Mortality } \% = \left[\frac{\mathrm{ED(mSv)}}{100}\ \mathrm{X}\ \frac{\mathrm{LAR\ (Cancer\ Mortality)}}{100000}\right]\mathrm{X}100 \quad \text{……...………….....} \quad (5)$$

**The effective dose calculations were used for the following comparisons:**

1) **Total population dose vs. global average comparison.**

To compare total results of ED and LAR of cancer incidence and mortality values for total population in this study with previous studies results.

**2) Private vs. governmental sector comparison.**

To compare effective doses and lifetime cancer risk values from private and governmental hospitals.

**3) Scanner vs. scanner comparisons (comparison between hospitals).**

To compare EDs and calculated LAR of cancer incidence and mortality values for each scanner with other scanners between hospitals.

### 4.8 Statistical analysis

Dose measurements, which are required for effective dose and the lifetime cancer risk assessment, were taken from the display monitor in the CT-scan unit and then, ED was assessed per patient by using the previous equations; collected data was used as input to Microsoft Excel version 2007.

### 4.9 Ethical considerations

- The proposal was submitted to Al-Quds University - Faculty of Public Health review board to obtain approval and permission to conduct the study.

- Approvals were obtained from the Ministry of Health to conduct the study in the governmental hospitals.

- Approvals were also obtained from the mangers of private hospitals, which were included in the study, to conduct the study in the private sector hospitals.

- Confidentiality of the gathered data was reserved. There were no identifying mechanisms, like codes, names, or even numbers, which might trace personal information to any specific patient. The study should not present any conflict of interest.

# Chapter Five

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# Results and Discussion

This chapter outlines the results of the study, ED estimations and applications of ED values for lifetime cancer risks incidence and mortality for total population with discussion of the results, limitations of the study, recommendations and future study.

## 5.1 Results

### 5.1.1. Parameters for abdominal-pelvis CT scans for total population:

Table 5.1 provides a summary of the parameters that affected EDs and LAR cancers risk assessment for total study population.

Table 5.1: Parameters of EDs and LAR cancer risk for total population.

| No. of patients | Percentage (%)/total study population | mAs | kVp | Scan length (mm) | Slice thickness (mm) | CTDIv (mGy) | DLP (mGy.cm) |
|---|---|---|---|---|---|---|---|
| 435 | 284.22 | 120 | 434.79 | 2.61 | 18.06 ± 6 | 918.26 ± 364.6 | 13.81 ± 5.4 |

### 5.1.2. ED and LAR of cancer incidence and mortality for total population:

For the total population, average effective dose was 11.80 ± 5.3 mSv, ranging between 0.50 and 36.79 mSv, which is in acceptable range of abdominal pelvis CT-dose for adults worldwide

The average lifetime attributable risk of cancer incidence in percentage was 0.083 % (1 in 2107) ranging between 0.001% (1 in 100000) and 0.245 % (1 in408).

While the average lifetime attributable risk of cancer mortality in percentage was 0.049% (1 in 3164) ranged between 0.001% (1 in 100000) and 0.193% (1 in 518). This is shown in Table 5.2.

Table 5.2: EDs and LAR of cancer risk incidence and mortality for total population.

| No. of patients | ED (mSv) | | LAR Inc % | | LAR Mort % | |
|---|---|---|---|---|---|---|
| | Average | Range | Average | Range | Average | Range |
| 435 | 11.80 ± 5.3 | 0.50 – 36.79 | 0.083 | 0.001- 0.245 | 0.049 | 0.001 - 0.193 |

The average effective dose for abdominal-pelvis CT of this study was 13.81 ± 5.4 mSv. The typical global effective doses for abdominal and pelvis CT is about 10 mSv. We found that there is a small difference between them, which is shifted toward higher LAR of cancer risk incidence, which was 0.097% (1 in 1031), and LAR of cancer mortality was 0.056% (1 in 1786).

### 5.1.3. Parameters for abdominal-pelvis CT scans per sector:

It was also noted that parameters for governmental sector were higher than those for private sector, since ED in private sector were 13 ± 6.7 mSv, 0.090% (1 in 1111), 0.053% (1 in 1887) respectively. While these parameters for governmental sector was 14.43 ± 3.8 mSv. LAR of cancer risk incidence was 0.103% (1 in 971), and LAR of cancer mortality was 0.063% (1 in 1587),

Table 5.3 provides a summary of the parameters that affected EDs and LAR cancers risk assessment for sectors.

Table 5.3: Parameters of EDs and LAR cancer risk for adult patients for sectors.

| Hospital | No. of patients | Percentage (%)/total study population | mAs | kVp | Scan length (mm) | Slice thickness (mm) | CTDIv (mGy) | DLP (mGy.cm) | Hospital | LAR Inc % | LAR Mor % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Priv. | 217 | 50 | 249.16 | 120 | 460.04 | 1.62 | 21.39 ± 7 | 878.77 ± 444.6 | 13 ± 6.7 | 0.090 | 0.053 |
| Gov. | 218 | 50 | 319.11 | 120 | 409.64 | 3.54 | 19.62 ± 4.3 | 957.57 ± 257 | 14.43 ± 3.8 | 0.103 | 0.063 |

### 5.1.4. ED and LAR of cancer incidence and mortality assessment for patients in sectors:

For **private sector** (which was equal 50% of the total study population), average effective dose was 11.45 ± 6.4 mSv, ranging between 1.77 and 36.79 mSv. The average lifetime attributable risk of cancer incidence in percentage was 0.077 % (1 in 1992) ranging between 0.008% (1 in 12500) and 0.245% (1 in 408). While the average life time attributable risk of cancer mortality in percentage was 0.046% (1 in 3166) ranging between 0.006% (1 in16667) and 0.156% (1 in 641).

For **governmental sector** (which also was equal 50 % of the total study population), average effective dose was 12.16 ± 4.1 mSv, ranging between 0.50 and 25.2 mSv. The average lifetime attributable risk of cancer incidence was 0.088 % (1 in 2215), ranging between 0.001 % (1 in 100000) and 0.233 % (1 in 429). While the average life time attributable risk of cancer mortality was 0.052 % (1 in 3163) ranging between 0.001 % (1 in 100000) and 0.193 % (1 in 518), as is shown in Table 5.8.

Table 5.4: EDs and LAR of cancer risk incidence and mortality in percentage for sectors.

| Sector | No. of patients | ED (mSv) | | LAR Inc % | | LAR Mort % | |
|---|---|---|---|---|---|---|---|
| | | Average | Range | Average | Range | Average | Range |
| Priv. | 217 | 11.45 ± 6.4 | 1.77 – 36.79 | 0.077 | 0.008 - 0.245 | 0.046 | 0.006 - 0.156 |
| Gov. | 218 | 12.16 ± 4.1 | 0.50 – 25.2 | 0.088 | 0.001- 0.233 | 0.052 | 0.001 - 0.193 |

### 5.1.5. Parameters for abdominal-pelvis CT scans per hospital:

1. **Princess Alia Hospital (P.A.H):**

Princess Alia Hospital was the most frequent CT examination source during the study period with 156 (36%) adult patients, with 79 females and 77 males.

The average tube voltage was 120 kVp, average tube current-time product was 365.9 mAs, and mean scan length was 414.6 mm. Slice thicknesses was 3.1 mm. This is shown in Table 5.5.

Table 5.5: Average parameters of abdominal-pelvis CT examination in P.A.H.

| Hospital | No. of patients | Percentage (%)/total study population | mAs | kVp | Scan length (mm) | Slice thickness (mm) | CTDIv (mGy) | DLP (mGy.cm) |
|---|---|---|---|---|---|---|---|---|
| P.A.H | 156 | 36 | 365.9 | 120 | 414.6 | 3.1 | 19.81 ± 4.1 | 831.1 ± 283.4 |

For Princess-Alia hospital (equal 36% of total study population), the average effective dose was 12.47 ± 4.3 mSv, ranging between 0.5 and 25.2 mSv.

The average lifetime attributable risk of cancer incidence in percentage was 0.092 % (1 in 2438) ranged between 0.001% (1 in 100000) and 0.233% (1 in 429).

The average life time attributable risk of cancer mortality was 0.054 % (1 in 3415), ranging between 0.001% (1 in 100000) and 0.193 % (1 in 518), as shown in Table 5.6.

Table 5.6: EDs and LAR of cancer risk incidence and mortality in percentage for P.A.H.

| Hospital | No. of patients | ED (mSv) | | LAR Inc % | | LAR Mort % | |
|---|---|---|---|---|---|---|---|
| | | Average | Range | Average | Range | Average | Range |
| P.A.H | 156 | 12.47 ± 4.3 | 0.5 - 25.2 | 0.092 | 0.001- 0.233 | 0.054 | 0.001 - 0.193 |

2. **Jenin Governmental Hospital (J.G.H):**

Jenin Governmental Hospital is one of the included governmental hospitals; where the total number of patients was 51 (12%) adult patients, with 30 females and 21 males.

The average tube voltage was 120 kVp, average tube current-time product was 202.4 mAs, and mean scan length was 397.75 mm. Slice thicknesses was 5 mm. This is shown in Table 5.7.

Table 5.7: Average parameters of abdominal-pelvis CT examination in J.G.H.

| Hospital | No. of patients | Percentage (%)/total study population | mAs | kVp | Scan length (mm) | Slice thickness (mm) | CTDIv (mGy) | DLP (mGy.cm) |
|---|---|---|---|---|---|---|---|---|
| J.G.H | 51 | 12 | 202.4 | 120 | 397.75 | 5 | 20.64 ± 3.3 | 818.2 ± 191.4 |

For Jeneen Governmental Hospital (which was equal 12% of the total study population), average effective dose was 12.27 ± 2.9 mSv, ranging between 6.1 and 17.85 mSv.

The average lifetime attributable risk of cancer incidence in percentage was 0.082% (1 in 1495) ranging between 0.023% (1 in 4348) and 0.206% (1 in 485).

While the average life time attributable risk of cancer mortality in percentage was 0.050 % (1 in 2258) ranging between 0.019 % (1 in 5263) and 0.096 % (1 in 1041), as shown in Table 5.8.

Table 5.8: EDs and LAR of cancer risk incidence and mortality in percentage for J.G.H.

| Hospital | No. of patients | ED (mSv) | | LAR Inc % | | LAR Mort % | |
|---|---|---|---|---|---|---|---|
| | | Average | Range | Average | Range | Average | Range |
| J.G.H | 51 | 12.27 ± 2.9 | 6.11 – 17.85 | 0.082 | 0.023 - 0.206 | 0.049 | 0.019 - 0.96 |

3. **Palestine Medical Complex (P.M.C):**

Palestine Medical Complex is one of the governmental hospitals; where the total number of patients was only 11 (2%) adult patients, with 9 females and 2 males.

The average tube voltage was 120 kVp, average tube current-time product was 197.5 mAs, and mean scan length was 394.4 mm. Average slice thicknesses was 3 mm. This is shown in Table 5.9.

Table 5.9: Average parameters of abdominal-pelvis CT examination in P.M.C.

| Hospital | No. of patients | Percentage (%)/total study population | mAs | kVp | Scan length (mm) | Slice thickness (mm) | CTDIv (mGy) | DLP (mGy.cm) |
|---|---|---|---|---|---|---|---|---|
| P.M.C | 11 | 2 | 197.55 | 120 | 394.4 | 3 | 12.15 ± 4.2 | 480.5 ± 177.3 |

For Palestine Medical Complex (which was 2% of the total study population), average effective dose was 7.21 ± 2.7 mSv, ranging between 2.84 and 11.31 mSv.

The average lifetime attributable risk of cancer incidence in percentage was 0.060 % (1 in 2383) ranging between 0.013 % (1 in 7692) and 0.116 % (1 in 862).

While the average life time attributable risk of cancer mortality in percentage was 0.034% (1 in 3773) ranging between 0.01% (1 in 10000) and 0.061% (1 in 1639), as shown in Table 5.10.

Table 5.10: EDs and LAR of cancer risk incidence and mortality in percentage for P. M.C.

| Hospital | No. of patients | ED (mSv) | | LAR Inc % | | LAR Mort % | |
|---|---|---|---|---|---|---|---|
| | | Average | Range | Average | Range | Average | Range |
| P.M.C | 11 | 7.21 ± 2.7 | 2.84 - 11.31 | 0.060 | 0.013 - 0.116 | 0.034 | 0.01 - 0.061 |

### 4. AL-Ahli Hospital (A.H):

AL-Ahli Hospital is one of the private hospitals; where the total number of patients was 104 (24%) adult patients, with 50 females and 54 males.

The average tube voltage was 120 kVp, average tube current-time product was 178 mAs, and mean scan length was 456.8 mm. Average slice thicknesses was 3 mm. This is shown in Table 5.11.

Table 5.11: Average measurements of abdominal-pelvis CT examination in A.H.

| Hospital | No. of patients | Percentage (%)/total study population | mAs | kVp | Scan length (mm) | Slice thickness (mm) | CTDIv (mGy) | DLP (mGy.cm) |
|---|---|---|---|---|---|---|---|---|
| A.H | 104 | 24 | 178 | 120 | 456.8 | 0.8 | 11.61 ± 4.8 | 528.4 ± 243.6 |

For Al-Ahli Hospital (which was equal only 24% of the total study population), average effective dose was 7.93 ± 3.7 mSv, ranging between 1.77 and 18.83 mSv.

The average lifetime attributable risk of cancer incidence in percentage was 0.050% (1 in 2602) ranging between 0.008% (1 in 12500) and 0.129% (1 in 775).

While the average life time attributable risk of cancer mortality in percentage was 0.031% (1 in 4061) ranging between 0.006% (1 in 16667) and 0.071% (1 in 1408), as shown in Table 5.12.

Table 5.12: EDs and LAR of cancer risk incidence and mortality in percentage for A.H.

| Hospital | No. of patients | ED (mSv) | | LAR Inc % | | LAR Mort % | |
|---|---|---|---|---|---|---|---|
| | | Average | Range | Average | Range | Average | Range |
| A.H | 104 | 7.93 ± 3.7 | 1.77 - 18.83 | 0.050 | 0.008 - 0.129 | 0.031 | 0.006 - 0.071 |

**5. Arab Istishari Hospital (A.I.H):**

Arab Istishari Hospital is one of the private hospitals; total number of patients was 90 (21%) adult patients, with 20 females and 63 males.

The average tube voltage was 120 kVp, average tube current-time product was 305.2 mAs, and mean scan length was 460.5 mm. Average slice thicknesses was 1.8 mm. This is shown in Table 5.13.

Table 5.13: Average parameters of abdominal-pelvis CT examination in A.I.H.

| Hospital | No. of patients | Percentage (%)/total study population | mAs | kVp | Scan length (mm) | Slice thickness (mm) | CTDIv (mGy) | DLP (mGy.cm) |
|---|---|---|---|---|---|---|---|---|
| A.I.H | 90 | 21 | 305.2 | 120 | 460.5 | 1.8 | 20.44 ± 3.8 | 950.3 ± 430.3 |

For Arab Istishari Hospital (which was about 21% of the total study population), the average effective dose was 14.25 ± 6.5 mSv, ranging between 3.02 and 36.79 mSv.

The average lifetime attributable risk of cancer incidence in percentage was 0.097% (1 in 1492) ranging between 0.019% (1 in 5263) and 0.239 % (1 in 418).

While the average life time attributable risk of cancer mortality in percentage was 0.056% (1 in 2466) ranging between 0.011% (1 in 9090) and 0.119 % (1 in 840), as shown in Table 5.14.

Table 5.14: EDs and LAR of cancer risk incidence and mortality for A.I.H.

| Hospital | No. of patients | ED (mSv) | | LAR Inc % | | LAR Mort % | |
|---|---|---|---|---|---|---|---|
| | | Average | Range | Average | Range | Average | Range |
| A.I.H | 90 | 14.25 ± 6.5 | 3.02 - 36.79 | 0.097 | 0.019 - 0.239 | 0.056 | 0.011 - 0.119 |

6. **AL-Razi Hospital (R.H):**

AL-Razi Hospital is one of the private hospitals; total number of patients was 23 (5%) adult patients, with 13 females and 10 males.

The average tube voltage was 120 kVp, average tube current-time product was 351.9 mAs, and mean scan length was 472.9 mm, average slice thicknesses was 5 mm. This is shown in Table 5.15.

Table 5.15: Average parameters of abdominal-pelvis CT examinations in R.H.

| Hospital | No. of patients | Percentage (%)/total study population | mAs | kVp | Scan length (mm) | Slice thickness (mm) | CTDIv (mGy) | DLP (mGy.cm) |
|---|---|---|---|---|---|---|---|---|
| R.H | 23 | 5 | 351.9 | 120 | 472.9 | 5 | 23.04 ± 9.6 | 1094 ± 480.3 |

For AL-Razi Hospital (which was equal only 5% of the total study population), average effective dose was 16.41 ± 7.2 mSv, ranging between 6.88 and 34.97 mSv.

The average lifetime attributable risk of cancer incidence in percentage was 0.122% (1 in 1187) ranging between 0.021% (1 in 4762) and 0.245% (1 in 408).

While the average life time attributable risk of cancer mortality in percentage was 0.071% (1 in 1856) ranging between 0.018% (1 in 5556) and 0.156% (1 in 641), as shown in Table 5.16.

Table 5.16: EDs and LAR of cancer risk incidence and mortality in percentage for R.H.

| Hospital | No. of patients | ED (mSv) | | LAR Inc % | | LAR Mort % | |
|---|---|---|---|---|---|---|---|
| | | Average | Range | Average | Range | Average | Range |
| R.H | 23 | 16.41 ± 7.2 | 6.88 - 34.97 | 0.122 | 0.021 - 0.245 | 0.071 | 0.018 - 0.156 |

## 5.2 Discussion

### 5.2.1. Summary of Parameters for abdominal-pelvis CT scans

Based on hospitals, the highest average EDs values in mSv, were in R.H with (16.41 ± 7.2) mSv, A.I.H (14.25 ± 6.5) mSv, J.G.H (12.27 ± 2.9) mSv, P.A.H (12.47 ± 4.3) mSv, while P.M.C (7.21 ± 2.7) mSv, A.H (7.93 ± 3.7) mSv.

.

Highest average ED in AL-Razi Hospital with 16.41 mSv, may refers to a high value of mAs with 351.9 and highest scan length value with 472.9mm, highest slice thickness with 5 mm, highest CTDIv with 23.04mGy, and highest DLP with 1094 mGy.cm.

While the Lowest average ED in P.M.C with 7.21 mSv, low value here also may refers to low values of mAs with 197 mAs, and lowest scan length with 394.4 mm, moderate slice thickness with 3 mm, low CTDIv with 12.15 mGy, and the lowest DLP value with 480.5 mGy.cm.

Whereas the highest value of LAR of cancer risk incidence was also in R.H (0.122%), P.A.H (0.092%), A.I.H (0.097%), J.G.H (0.082%), P.M.C (0.060%), and the lowest value in A.H (0.050).

Based on LAR of cancer risk mortality also because of the highest average ED dose in this hospital, the highest value also was in R.H (0.0.071%), P.A.H (0.054 %), A.I.H (0.056%), J.G.H (0.050 %), P.M.C (0.034%), and the lowest value in A.H (0.031%). Table 5.17 provides a summary of the parameters that for included hospitals.

Table 5.17: Parameters of EDs and LAR cancer risk for adult patients in six hospitals.

| Hospital | No. of patients | Percentage (%)/total study population | mAs | kVp | Scan length (mm) | Slice thickness (mm) | CTDIv (mGy) | DLP (mGy.cm) | ED (mSv) | LAR Inc % | LAR Mor % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| P.A.H | 156 | 36 | 365.9 | 120 | 414.6 | 3.1 | 19.81 ± 4.1 | 831.1 ± 283.4 | 12.47 ± 4.3 | 0.092 | 0.054 |
| J.G.H | 51 | 12 | 202.4 | 120 | 397.75 | 5 | 20.64 ± 3.3 | 818.2 ± 191.4 | 12.27 ± 2.9 | 0.082 | 0.049 |
| P.M.C | 11 | 2 | 197.55 | 120 | 394.4 | 3 | 12.15 ± 4.2 | 480.5 ± 177.3 | 7.21 ± 2.7 | 0.060 | 0.034 |
| A.H | 104 | 24 | 178 | 120 | 456.8 | 0.8 | 11.61 ± 4.8 | 528.4 ± 243.6 | 7.93 ± 3.7 | 0.050 | 0.031 |
| A.I.H | 90 | 21 | 305.2 | 120 | 460.5 | 1.8 | 20.44 ± 3.8 | 950.3 ± 430.3 | 14.25 ± 6.5 | 0.0.97 | 0.056 |
| R.H | 23 | 5 | 351.9 | 120 | 472.9 | 5 | 23.04 ± 9.6 | 1094 ± 480.3 | 16.41 ± 7.2 | 0.122 | 0.071 |

There is a notable wide variation between CTDIv, DLP, and ED values for six included hospitals in Palestine, since the value of CTDIv ranging from 11.61 to 23.04 mGy, and DLP values ranging between 480.5 and 1094 mGy.cm, so that ED values ranging between 7.21 and

16.41 mSv, four hospitals from six had ED value higher than global value of abdominal-pelvis CT which is equal nearly 10 mSv.

CTDIv values for adult patients in the included hospitals are presented in Figure 5.1. The values were higher in R.H, J.G.H, A.I.H, and P.A.H.

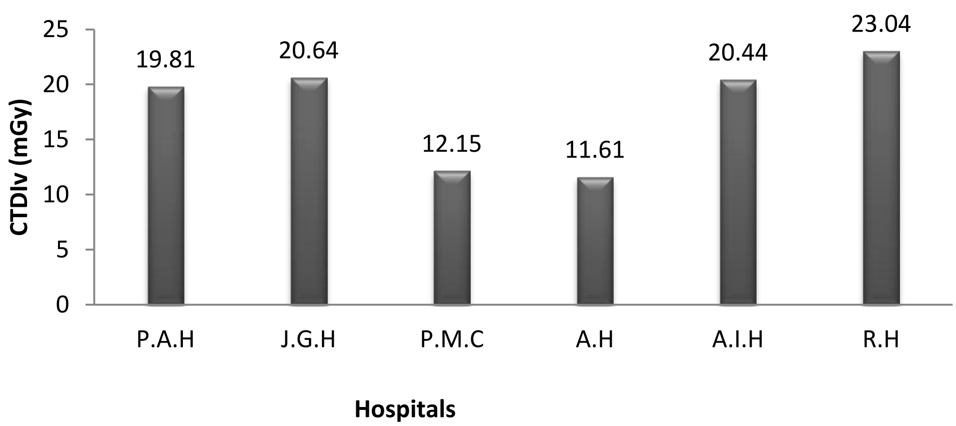


Figure 5.1: CTDIv values in the included hospitals.

There is a strong positive relationship between CTDIv and effective doses in the included hospital, as it shown in figure 5.2.

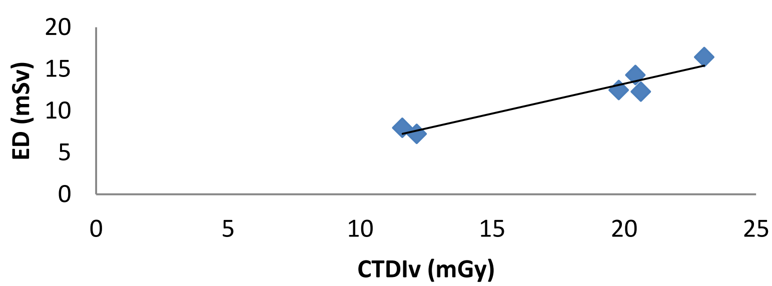


Figure 5.2: Correlation between CTDIv and effective dose for patients in all included hospitals.

DLP values for adult patients in the included hospitals are presented in Figure 5.3. The values were higher in J.G.H, R.H and P.A.H; two of them are governmental hospitals.

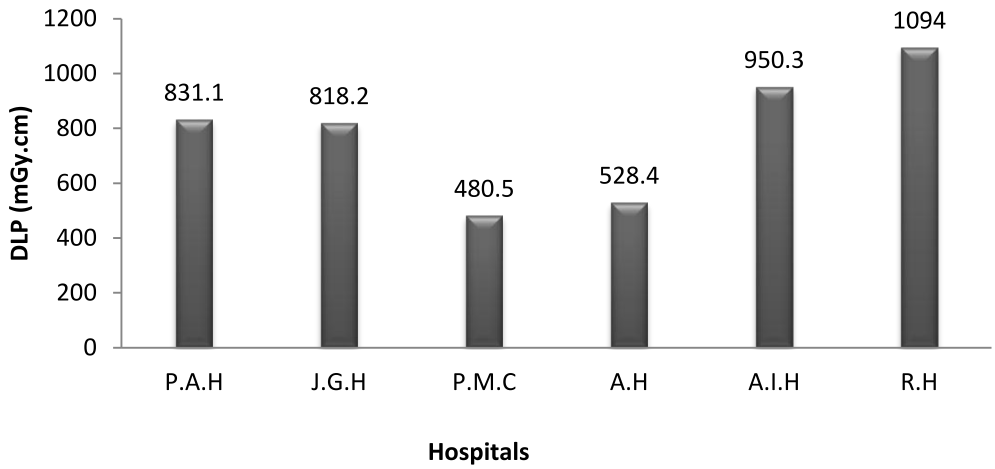


Figure 5.3: DLP values for adult patients in the included hospitals.

Average ED values for adult patients in the included hospitals are presented in figure 5.4. The values were higher in R.H, A.I.H, J.G.H, and P.A.H.

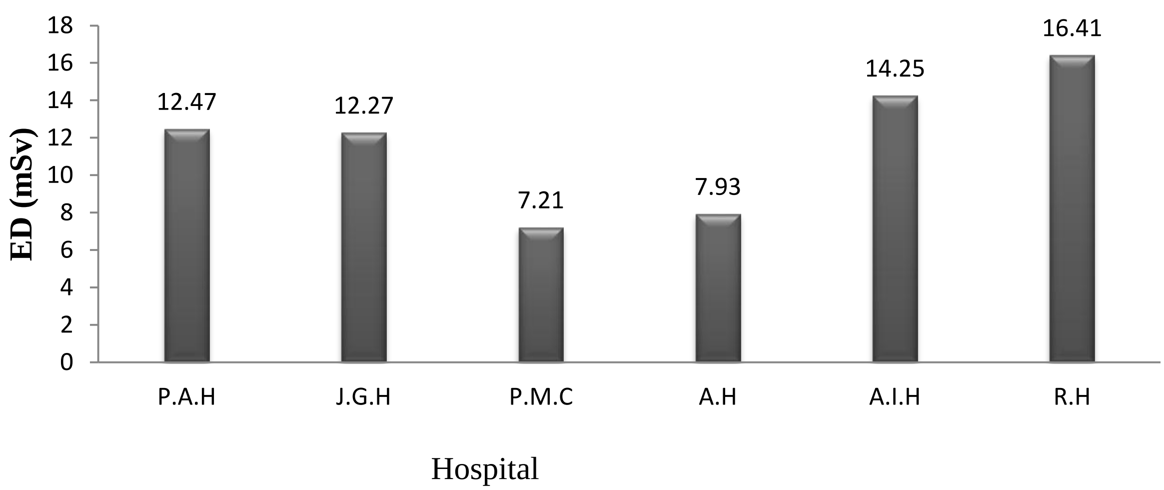


Figure 5.4: Distribution of average ED values for adult patients in the included hospitals.

### 5.2.2 Relationship between parameters and Effective dose for total population in six hospitals in West Bank:

Figure 5.5 shows correlation between mAs and ED for total study population. Showed strong positive relationship between two values.

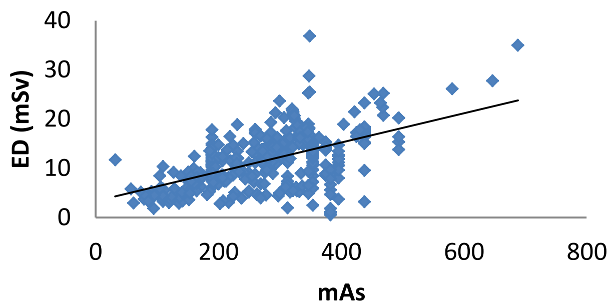


Figure 5.5: Correlation between mAs and ED for total study population.

Figure 5.6 shows correlation between scan length and ED for total study population. Increase in scan length was associated with increase in average ED value.

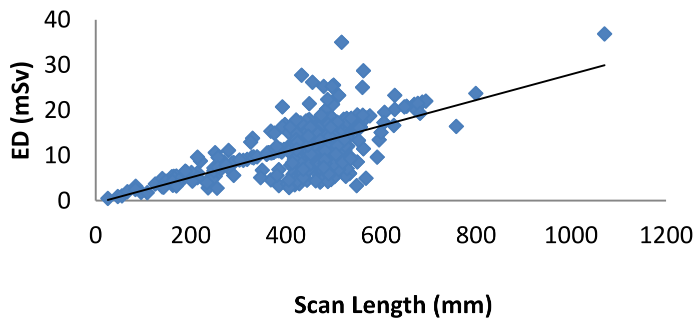


Figure 5.6: Correlation between scan length and ED for total study population.

Figure 5.7 shows correlation between CTDIv and ED for total study population. There is a strong positive or direct relationship between CTDIv and ED value, trendline shows that any increase in CTDIv will be associated with increase in average ED value.

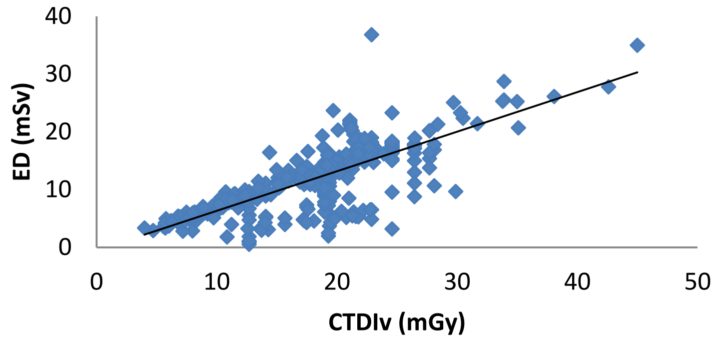


Figure 5.7: Correlation between CTDIv and ED for total study population.

### 5.2.3 CT radiation doses comparison between Palestine and other international dose level references

#### 5.2.3.1 Comparison between CTDIv, DLP and effective dose for adult patient's abdominal-pelvis CT in Palestine and other countries:

In comparison with various dose reference levels, Palestine is in acceptable level in CTDIv, DLP and effective dose values. Figure 5.8 shows CTDIv in various references, values ranging between 12 to 25 mGy; while West Bank was 18.06 mGy.

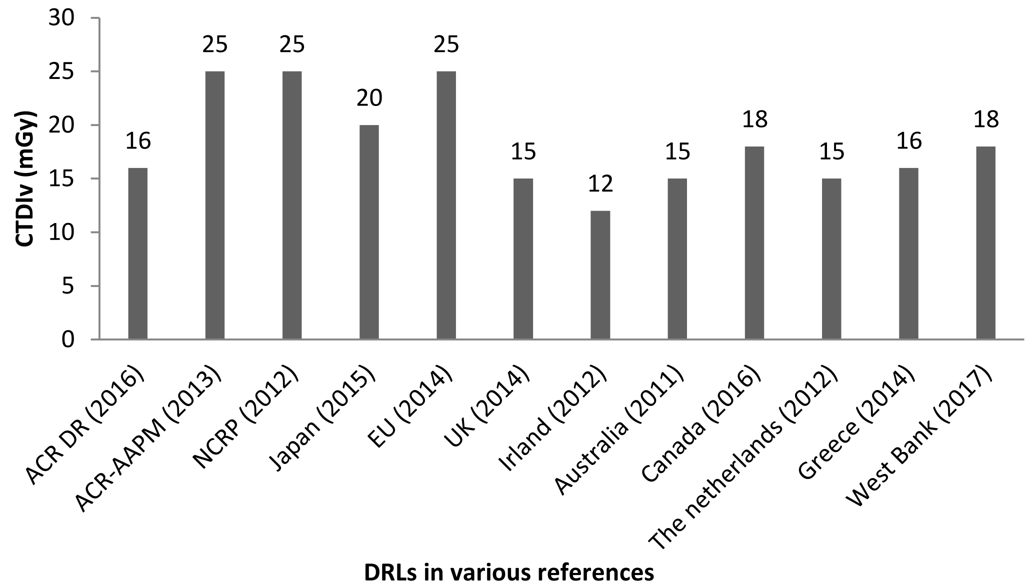


Figure 5.8: Comparison between CTDIv parameters in various references worldwide.

While figure 5.9 shows DLP in various references ("Cite a Website - Cite This For Me", 2018), values ranging between 600 to 1000 mGy.cm, while West Bank was 787 mGy.cm.

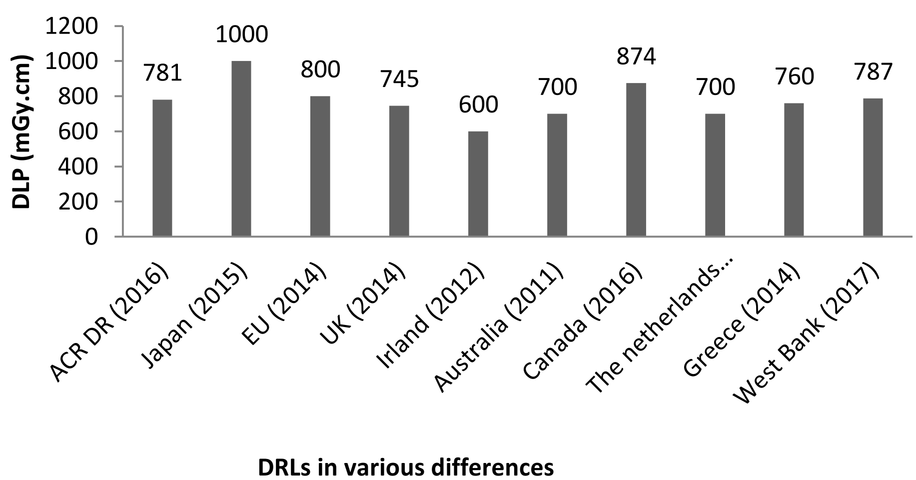


Figure 5.9: Comparison between DLP parameters in various references worldwide.

Figure 5.10 shows a comparison between the average ED for abdominal-pelvis CT in this work with various references international dose reference levels and also with other published data for the same procedure. In this figure average ED ranging between 7.1 to 16.7 mSv. The differences in these values may be due to differences in CT-scan protocols and scanners types or specifications. Generally, our estimated average ED in abdominal-pelvis CT examinations was 11.8 mSv, which is lower than the reference doses from European Union (EU) with 15.6 mSv.

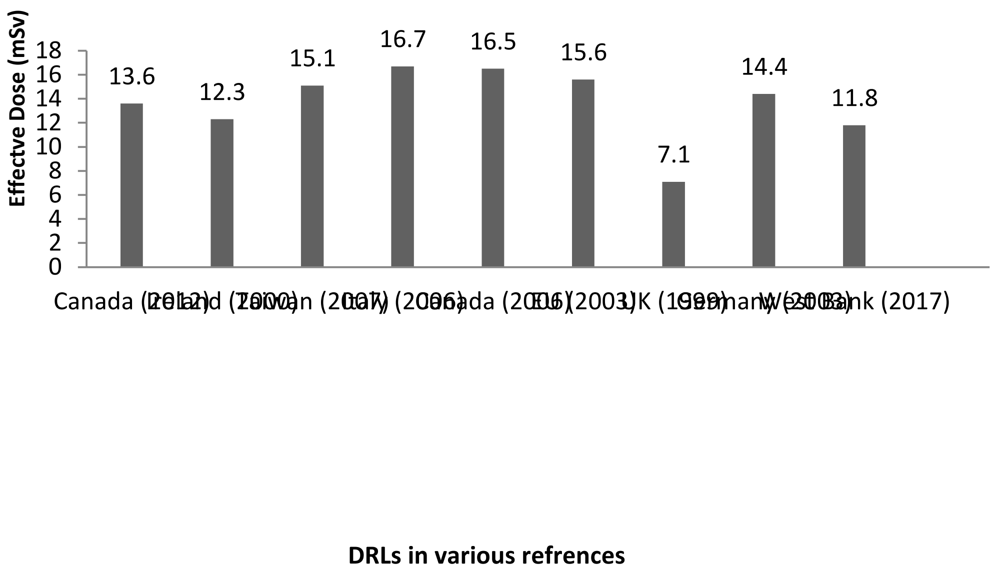


Figure 5.10: Comparison between average EDs in various references worldwide.

### 5.2.4. Age dependant EDs and LAR:

#### 5.2.4.1. Age dependant EDs and LAR for total study population:

Figure 5.10, 11 and 12 show correlation between patient's age with ED, LAR Inc % and Mor % for total study population. Figure 5.11 shows correlation between ages with ED for total study population. There is a very weak positive or direct relationship between age and ED value.

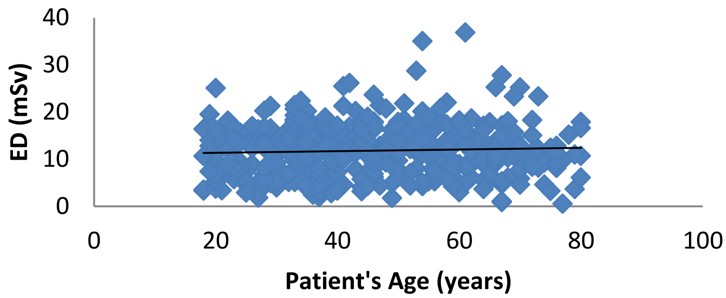


Figure 5.11: Correlation between Age and ED for total study population.

Figure 5.12 shows correlation between ages with LAR Inc % for total study population. There is a positive relationship between ages and LAR Inc % value, so that the lifetime cancer risk incidence weakly associated with patient age. Trendline shows that LAR Inc % decrease while ages increase.

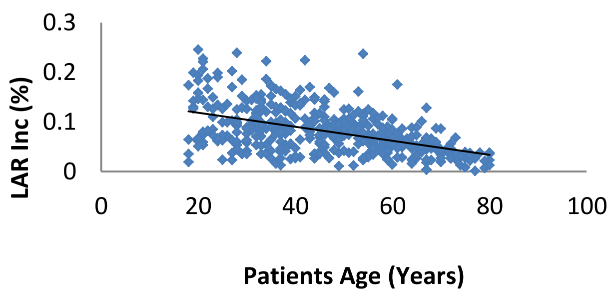


Figure 5.12: Correlation between Age and LAR Inc % for total study population.

Figure 5.12 shows correlation between ages with LAR Mor % for total study population. The correlation coefficient is 0.102. This is also a weak relationship between ages and LAR Mor % value, so that the lifetime cancer risk mortality weakly associated with patient age. Trendline shows that LAR Mor % decrease while ages increase.

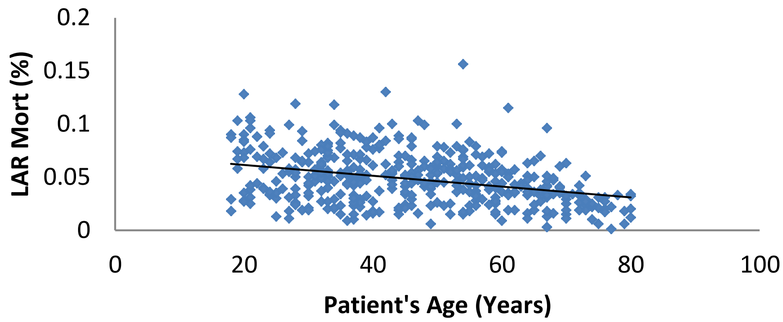


Figure 5.13: Correlation between Age and LAR Mor % for total study population.

### 5.2.4.2. Age dependant LAR for adult patients abdominal-pelvis CT in different hospitals in the WestBank:

Correlation between ages and estimated lifetime attributable cancer risk incidence and mortality for patients underwent abdominal-pelvis CT in included hospitals is shown in Figure 5.14 to figure 5.25. The lifetime attributable cancer risk incidence and mortality were decreased while ages increases and vice versa. Younger patients have more radiosensitivty than adult patients; so that they have more lifetime cancer risk.

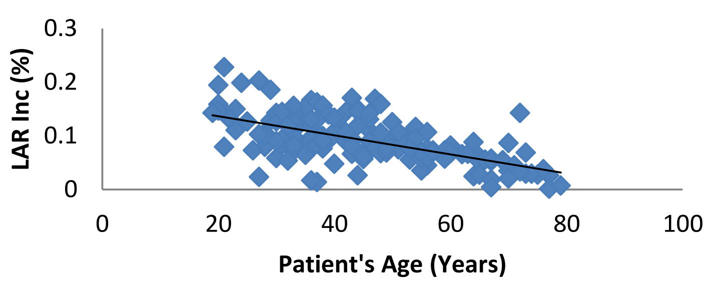


Figure 5.14: Correlation between lifetime attributable cancer risk incidences from abdominal-pelvis CT in P.A.H.

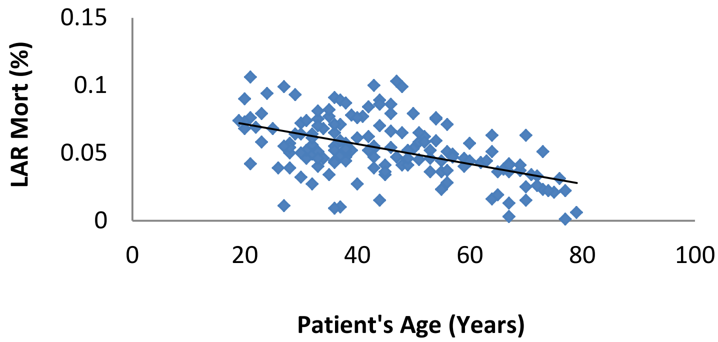


Figure 5.15: Correlation between lifetime attributable cancer risk mortality from abdominal-pelvis CT in P.A.H.

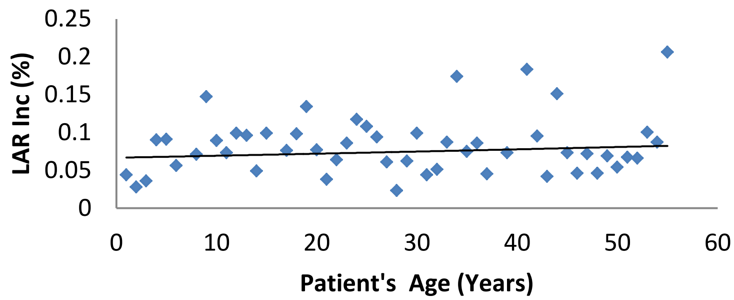


Figure 5.16: Correlation between lifetime attributable cancer risk incidences from abdominal-pelvis CT in J.G.H.

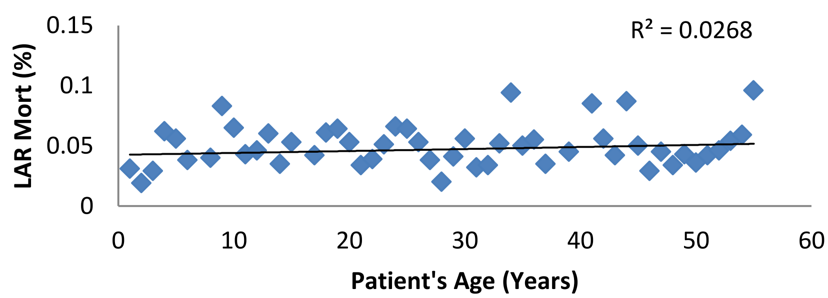


Figure 5.17: Correlation between lifetime attributable cancer risk mortality from abdominal-pelvis CT in J.G.H.

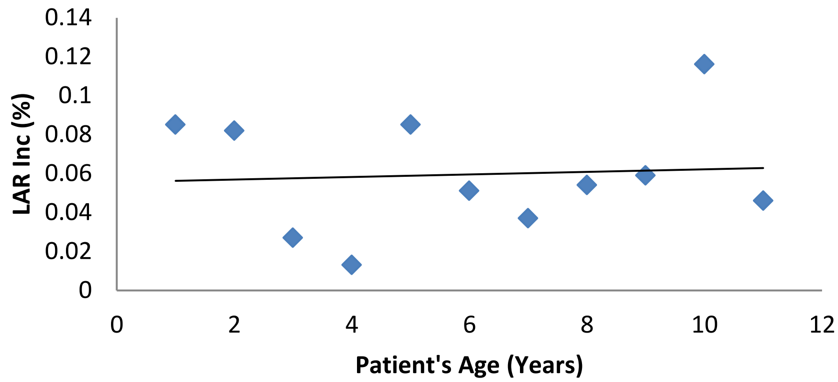


Figure 5.18: Correrlation between lifetime attributable cancer risk incidences from abdominal-pelvis CT in P.M.C.

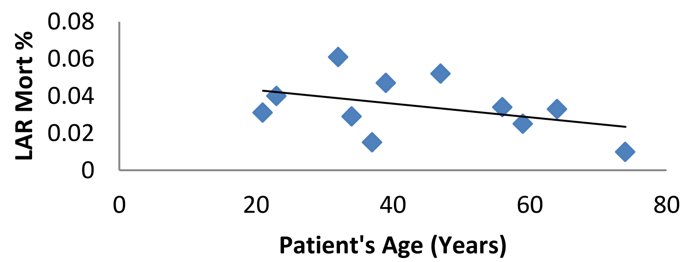


Figure 5.19: Correlation between lifetime attributable cancer risk mortalityfrom abdominal-pelvis CT in P.M.C.

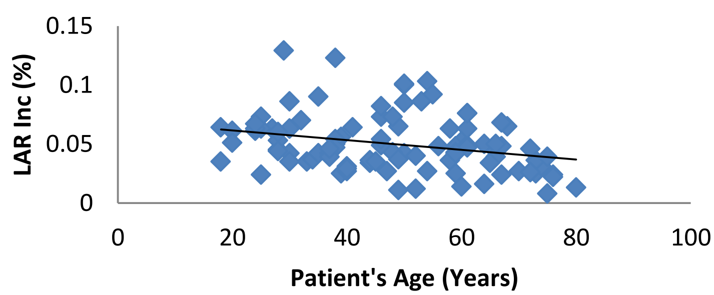


Figure 5.20: Correlation between lifetime attributable cancer risk incidences from abdominal-pelvis CT in A.H.

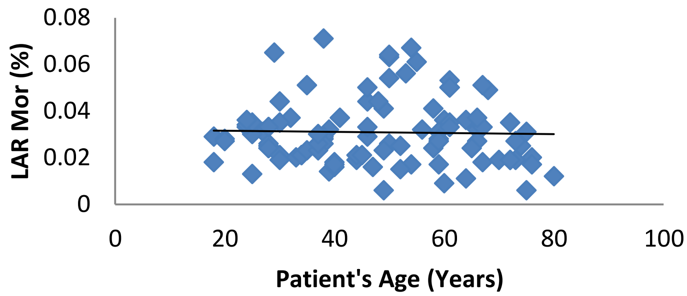


Figure 5.21: Correlation between lifetime attributable cancer risk mortality from abdominal-pelvis CT in A.H.

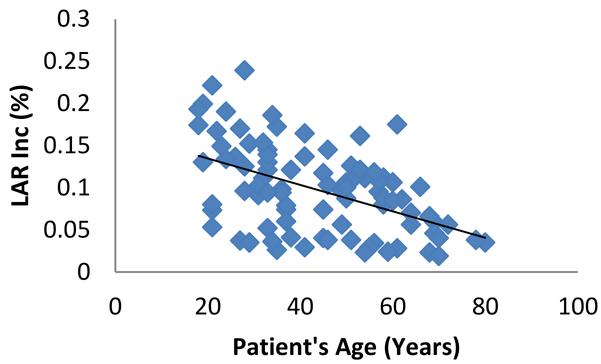


Figure 5:22: Correlation between lifetime attributable cancer risk incidence from abdominal-pelvis CT in A.I.H.

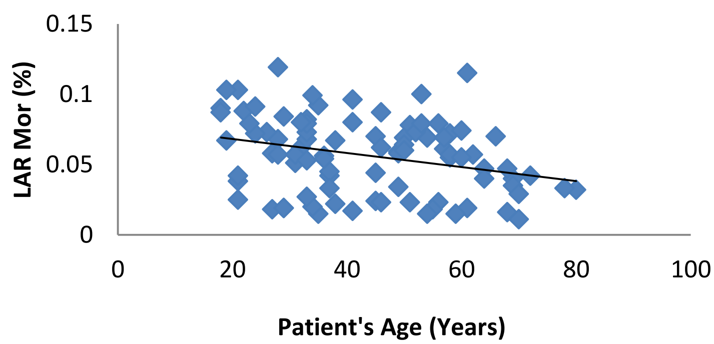


Figure 5.23: Correlation between lifetime attributable cancer risk mortality from abdominal-pelvis CT in A.I.H.

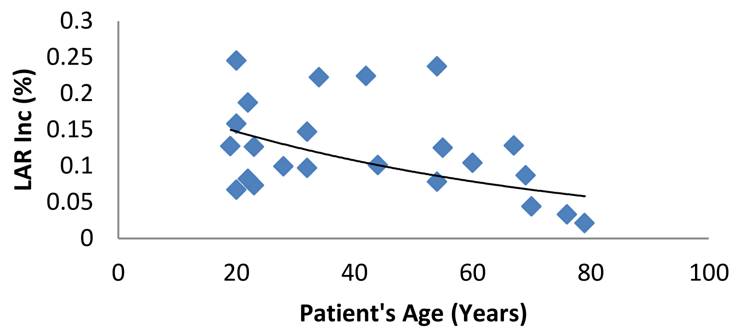


Figure 24: Correlation between lifetime attributable cancer risk incidence from abdominal-pelvis CT in R.H.

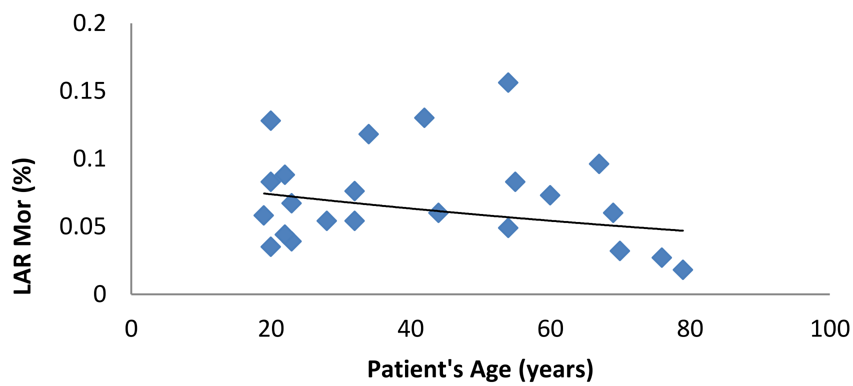


Figure 5.25: Correlation between lifetime attributable cancer risk mortality from abdominal-pelvis CT in R.H.

### 5.2.5. Sex dependant EDs and LAR:

#### 5.2.5.1. Measurements of EDs and LAR based on patient's Sex for total study population:

Average ED for male patients (53% of the total study population) was little higher than that for female (47 % of the total study population) with 13.42, 14.15 mSv respectively, as shown in Table 5.18.

Table 5.18: Average EDs and LAR Inc and LAR Mort percentages for adult patients undergoing abdominal-pelvis CT in total study population based on sex.

| Sex | ED (mSv) | LAR Inc % | LAR Mort % |
|---|---|---|---|
| **F** | 13.42 | 0.085 | 0.062 |
| **M** | 14.15 | 0.087 | 0.051 |

#### 5.2.5.2. Measurements of EDs and LAR based on patient's Sex for P.A.H:

Measurements of lifetime attributable cancer risk incidence and mortality from abdominal-pelvis CT in P.A.H foe female and male patients was shown in fiure 5.25, 26,27,28.

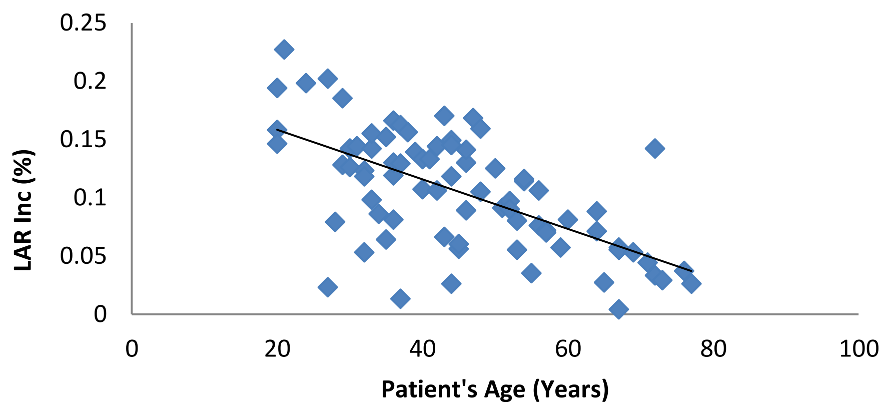


Figure 5.26: Correlation between lifetime attributable cancer risk incidence for female from abdominal-pelvis CT in P.A.H.

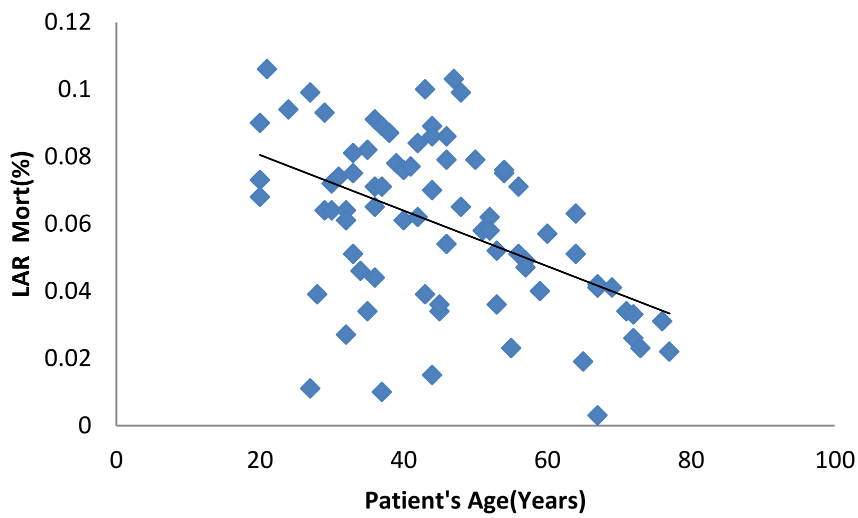


Figure 5.27: Correlation between lifetime attributable cancer risk mortality for female from abdominal-pelvis CT in P.A.H.

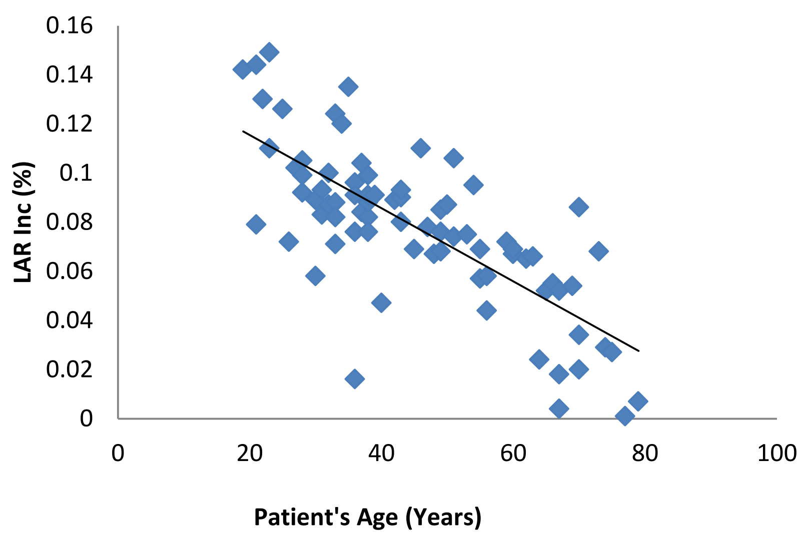


Figure 5.28: Correlation between lifetime attributable cancer risk incidence for male from abdominal-pelvis CT in P.A.H.

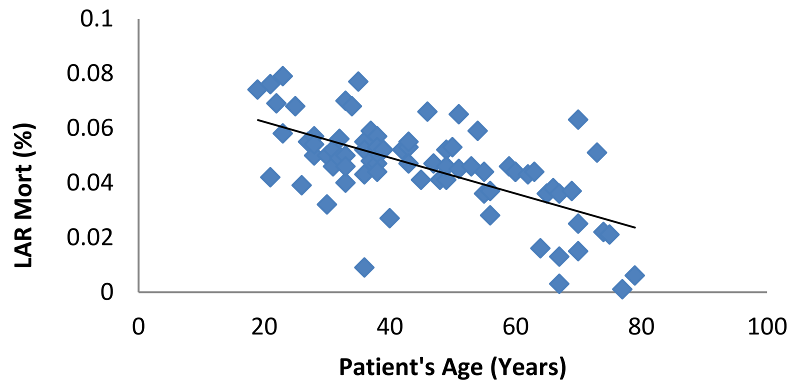


Figure 5.29: Correlation between lifetime attributable cancer risk mortality for male from abdominal-pelvis CT in P.A.H.

### 5.3 Study Limitations

Different limitations affected the quality and how easily we conducted this study. Some limitations are related to political conditions in the West Bank. Check points between cities, which make the movement between hospitals very difficult, and therefore the study, will need a lot of time, effort, and cost.

In data collection stage, we had some difficulties in dealing with radiologists and radiographers, because of huge work load and stress during the working day. In addition, radiographers may need to delete patient's records in a very short period, which make it very hard to include larger number of patients in the study. Files with missing information (especially patient age and/or sex), were excluded from the study, to prevent bias.

### 5.4 Conclusion

Finally, the estimated average effective dose for adult patients who underwent abdominal-pelvis CT examinations in this work was acceptable, since it was 11.8 ± 5.3 mSv for the total syudy population ranged between 0.5 mSv and 36.79 mSv. In sectors, average effective dose was 11.45 ± 6.4 mSv for private (50% of total study population) ranged between 1.77 mSv and 36.79 mSv, and 12.16 ± 4.1 mSv for governmental (50% of total study population) ranged between 0.5 mSv and 25.2 mSv .

Based on hospitals, the highest average EDs values in mSv, were in R.H with (16.41 ± 7.2) mSv, A.I.H (14.25 ± 6.5) mSv, J.G.H (12.27 ± 2.9) mSv, P.A.H (12.47 ± 4.3) mSv, while P.M.C (7.21 ± 2.7) mSv, A.H (7.93 ± 3.7) mSv.

LAR cancer risk incidence values in hospitals, whereas the highest was in R.H with 0.122 (1 in 1187) which is low, P.A.H 0.091% (1 in 2463) low, A.I.H with 0.097% (1 in 1493) low, J.G.H 0.082% (1 in 1495) low, P.M.C 0.060% (1 in 2383) low, A.H 0.050 % (1 in 2602) low.

The highest LAR cancer risk Mortality values in hospitals was in R.H with 0.071% (1 in 1856) low, P.A.H 0.054% (1 in 3415) low, A.I.H with 0.056 % (1 in 2466) low, J.G.H 0.050 % (1 in 2258) low, P.M.C 0.034 % (1 in 3773) low, A.H 0.031% (1 in 4061) low.

### 5.5 Recommendations

1) Requests for abdominal-pelvis CT-examinations should be done only by qualified physicians who have adequate knowledge and awareness about CT-dose and attributed lifetime cancer risk or other stochastic and deterministic effects of a high radiation exposure. Such requests should be also reviewed by radiologists to make sure the examination is needed, since requesting these examinations must depend on ALARA principle, diagnosis quality, and patient safety.

2) Devising Guidelines for doctors about necessity of CT and who to judge and balance between the risks and benefits, and diagnosis quality, when they must choose CT, and

when they must choose one of the alternatives which haven't or have a low radiation dose such as Ultrasound (U/S), MRI or plain X-ray, if possible.

3) Continuous training for physicians, radiologists, and radiographers about CT-dose risks and benefits, whom to choose the most suitable modality, and how to optimize CT-dose if it is needed.

4) Using Global Dose Management Software is recommended to help in dose analysis, quality assurance, and follow-up.

5) Medical engineers and physicists and other CT-scanner specialists must perform quality control tests to ensure that machines work effectively with the best quality and safety for patients and workers from any excessive radiation dose due to CT-machine mechanical problems.

6) National survey can be used as a solution for a large difference between hospitals in the average effective dose; results of such survey can establish a national diagnostic reference level and protocol for CT-dose optimization for all scanners in Palestine, and to check for unnecessary radiation dose and how to eliminate such exposure.

7) Patient him/herself and his/her family should be aware and educated about the possible risks and adverse health effects. Efforts should be done to increase people's knowledge on this issue.

## 5.6 Future study

More studies and researches about this public health problem should be done in Palestine to determine the reasons of high CT-doses and the rapid increase of the rate of requesting and using CT-scans in the last two years, while there are a global trends and notable intensive efforts to decrease this rate by using other medical imaging alternatives.

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# APPENDICES

# APPENDIX A

Table A.1: Parameters of Abdominal and pelvis CT examinations

| ID | Age | Sex | mAs | Scan length | T | CTDIv | DLP | ED (mSv) | LAR Inc (%) | LAR Mor (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Princess Alia Hospital** | | | | | | | | | | |
| 1 | 46 | M | 438 | 486 | 3 | 24.6 | 1195.56 | 17.9334 | 0.11 | 0.066 |
| 2 | 28 | M | 313 | 471 | 3 | 17.5 | 824.25 | 12.36375 | 0.092 | 0.05 |
| 3 | 42 | F | 438 | 456 | 3 | 24.6 | 1121.76 | 16.8264 | 0.144 | 0.084 |
| 4 | 72 | F | 354 | 389 | 3 | 19.3 | 750.77 | 11.26155 | 0.142 | 0.033 |
| 5 | 24 | F | 375 | 444 | 3 | 21 | 932.4 | 13.986 | 0.198 | 0.094 |
| 6 | 35 | M | 494 | 486 | 3 | 27.7 | 1346.22 | 20.1933 | 0.135 | 0.077 |
| 7 | 32 | M | 354 | 507 | 3 | 19.3 | 978.51 | 14.67765 | 0.1 | 0.056 |
| 8 | 56 | M | 383 | 441 | 3 | 12.7 | 560.07 | 8.40105 | 0.044 | 0.028 |
| 9 | 23 | M | 438 | 453 | 3 | 24.6 | 1114.38 | 16.7157 | 0.149 | 0.079 |
| 10 | 67 | M | 354 | 462 | 3 | 19.3 | 891.66 | 13.3749 | 0.052 | 0.036 |
| 11 | 54 | F | 434 | 399 | 5 | 28.1 | 1121.19 | 16.81785 | 0.114 | 0.075 |
| 12 | 53 | F | 313 | 435 | 3 | 17.6 | 765.6 | 11.484 | 0.08 | 0.052 |
| 13 | 36 | F | 438 | 471 | 3 | 24.6 | 1158.66 | 17.3799 | 0.166 | 0.091 |
| 14 | 43 | F | 494 | 486 | 3 | 27.7 | 1346.22 | 20.1933 | 0.17 | 0.1 |
| 15 | 28 | M | 354 | 486 | 3 | 19.3 | 937.98 | 14.0697 | 0.105 | 0.057 |
| 16 | 60 | F | 354 | 480 | 3 | 19.3 | 926.4 | 13.896 | 0.081 | 0.057 |
| 17 | 75 | M | 396 | 361 | 3 | 19.4 | 700.34 | 10.5051 | 0.027 | 0.021 |
| 18 | 35 | F | 354 | 495 | 3 | 21 | 1039.5 | 15.5925 | 0.152 | 0.082 |
| 19 | 41 | F | 375 | 486 | 3 | 21 | 1020.6 | 15.309 | 0.133 | 0.077 |
| 20 | 36 | M | 354 | 498 | 3 | 19.3 | 961.14 | 14.4171 | 0.096 | 0.055 |
| 21 | 25 | M | 375 | 483 | 3 | 21 | 1014.3 | 15.2145 | 0.126 | 0.068 |
| 22 | 38 | M | 396 | 429 | 3 | 19.4 | 832.26 | 12.4839 | 0.082 | 0.047 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 23 | 38 | M | 354 | 519 | 3 | 19.3 | 1001.67 | 15.02505 | 0.099 | 0.057 |
| 24 | 73 | F | 383 | 429 | 3 | 12.7 | 544.83 | 8.17245 | 0.029 | 0.023 |
| 25 | 65 | M | 354 | 435 | 3 | 19.3 | 839.55 | 12.59325 | 0.052 | 0.036 |
| 26 | 64 | M | 383 | 291 | 3 | 12.7 | 369.57 | 5.54355 | 0.024 | 0.016 |
| 27 | 30 | M | 354 | 291 | 3 | 19.3 | 561.63 | 8.42445 | 0.058 | 0.032 |
| 28 | 28 | F | 383 | 351 | 3 | 12.7 | 445.77 | 6.68655 | 0.079 | 0.039 |
| 29 | 43 | M | 354 | 492 | 3 | 19.3 | 949.56 | 14.2434 | 0.09 | 0.053 |
| 30 | 42 | M | 354 | 483 | 3 | 19.3 | 932.19 | 13.98285 | 0.089 | 0.052 |
| 31 | 38 | M | 32 | 444 | 3 | 17.5 | 777 | 11.655 | 0.076 | 0.044 |
| 32 | 32 | F | 313 | 456 | 3 | 17.5 | 798 | 11.97 | 0.123 | 0.064 |
| 33 | 28 | M | 354 | 459 | 3 | 19.3 | 885.87 | 13.28805 | 0.099 | 0.054 |
| 34 | 53 | F | 396 | 273 | 3 | 19.4 | 529.62 | 7.9443 | 0.055 | 0.036 |
| 35 | 55 | F | 250 | 249 | 3 | 14.1 | 351.09 | 5.26635 | 0.035 | 0.023 |
| 36 | 40 | M | 354 | 249 | 3 | 19.3 | 480.57 | 7.20855 | 0.047 | 0.027 |
| 37 | 26 | M | 383 | 468 | 3 | 12.7 | 594.36 | 8.9154 | 0.072 | 0.039 |
| 38 | 34 | F | 383 | 456 | 3 | 12.7 | 579.12 | 8.6868 | 0.086 | 0.046 |
| 39 | 40 | F | 354 | 414 | 3 | 19.4 | 803.16 | 12.0474 | 0.107 | 0.061 |
| 40 | 74 | M | 375 | 252 | 3 | 28.1 | 708.12 | 10.6218 | 0.029 | 0.022 |
| 41 | 65 | F | 250 | 252 | 5 | 14.1 | 355.32 | 5.3298 | 0.027 | 0.193 |
| 42 | 66 | M | 354 | 477 | 3 | 19.3 | 920.61 | 13.80915 | 0.055 | 0.038 |
| 43 | 52 | F | 375 | 432 | 3 | 21 | 907.2 | 13.608 | 0.097 | 0.062 |
| 44 | 70 | M | 283 | 465 | 5 | 14.1 | 655.65 | 9.83475 | 0.034 | 0.025 |
| 45 | 77 | F | 354 | 333 | 3 | 19.3 | 642.69 | 9.64035 | 0.026 | 0.022 |
| 46 | 55 | M | 396 | 364 | 3 | 19.4 | 706.16 | 10.5924 | 0.057 | 0.036 |
| 47 | 37 | M | 313 | 543 | 3 | 19.3 | 1047.99 | 15.71985 | 0.104 | 0.059 |
| 48 | 37 | F | 438 | 467 | 3 | 24.6 | 1148.82 | 17.2323 | 0.162 | 0.089 |
| 49 | 67 | F | 354 | 414 | 3 | 19.3 | 799.02 | 11.9853 | 0.055 | 0.041 |
| 50 | 29 | F | 313 | 434 | 3 | 17.5 | 759.5 | 11.3925 | 0.128 | 0.064 |
| 51 | 51 | F | 396 | 432 | 3 | 19.4 | 838.08 | 12.5712 | 0.091 | 0.058 |
| 52 | 39 | M | 354 | 480 | 3 | 19.3 | 926.4 | 13.896 | 0.091 | 0.052 |
| 53 | 69 | M | 313 | 495 | 3 | 19.3 | 955.35 | 14.33025 | 0.054 | 0.037 |
| 54 | 21 | M | 313 | 525 | 3 | 19.3 | 1013.25 | 15.19875 | 0.144 | 0.076 |
| 55 | 56 | F | 271 | 447 | 3 | 17.6 | 786.72 | 11.8008 | 0.076 | 0.051 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 56 | 64 | F | 271 | 474 | 3 | 19.4 | 919.56 | 13.7934 | 0.071 | 0.051 |
| 57 | 50 | M | 313 | 504 | 3 | 19.4 | 977.76 | 14.6664 | 0.087 | 0.053 |
| 58 | 45 | M | 396 | 384 | 3 | 19.4 | 744.96 | 11.1744 | 0.069 | 0.041 |
| 59 | 50 | F | 438 | 456 | 3 | 24.6 | 1121.76 | 16.8264 | 0.125 | 0.079 |
| 60 | 20 | F | 396 | 329 | 3 | 19.4 | 638.26 | 9.5739 | 0.158 | 0.073 |
| 61 | 57 | F | 313 | 435 | 3 | 17.5 | 761.25 | 11.41875 | 0.072 | 0.049 |
| 62 | 33 | M | 354 | 365 | 3 | 19.3 | 704.45 | 10.56675 | 0.071 | 0.04 |
| 63 | 56 | M | 354 | 381 | 3 | 19.3 | 735.33 | 11.02995 | 0.058 | 0.037 |
| 64 | 54 | F | 438 | 462 | 3 | 24.6 | 1136.52 | 17.0478 | 0.116 | 0.076 |
| 65 | 36 | F | 375 | 270 | 3 | 21 | 567 | 8.505 | 0.081 | 0.044 |
| 66 | 64 | F | 438 | 462 | 3 | 24.6 | 1136.52 | 17.0478 | 0.088 | 0.063 |
| 67 | 33 | F | 354 | 486 | 3 | 19.3 | 937.98 | 14.0697 | 0.142 | 0.075 |
| 68 | 49 | M | 354 | 492 | 3 | 19.4 | 954.48 | 14.3172 | 0.085 | 0.052 |
| 69 | 33 | M | 313 | 498 | 3 | 17.5 | 871.5 | 13.0725 | 0.088 | 0.05 |
| 70 | 67 | F | 354 | 423 | 3 | 19.3 | 816.39 | 12.24585 | 0.057 | 0.042 |
| 71 | 67 | F | 354 | 414 | 3 | 19.3 | 799.02 | 11.9853 | 0.055 | 0.041 |
| 72 | 44 | F | 438 | 489 | 3 | 24.6 | 1202.94 | 18.0441 | 0.149 | 0.089 |
| 73 | 51 | M | 354 | 438 | 3 | 19.4 | 849.72 | 12.7458 | 0.074 | 0.045 |
| 74 | 21 | F | 375 | 453 | 3 | 21 | 951.3 | 14.2695 | 0.227 | 0.106 |
| 75 | 21 | M | 313 | 288 | 3 | 19.3 | 555.84 | 8.3376 | 0.079 | 0.042 |
| 76 | 22 | M | 354 | 489 | 3 | 19.3 | 943.77 | 14.15655 | 0.13 | 0.069 |
| 77 | 44 | F | 438 | 474 | 3 | 24.6 | 1166.04 | 17.4906 | 0.145 | 0.086 |
| 78 | 44 | F | 438 | 85 | 3 | 24.6 | 209.1 | 3.1365 | 0.026 | 0.015 |
| 79 | 70 | M | 354 | 204 | 3 | 19.3 | 393.72 | 5.9058 | 0.02 | 0.015 |
| 80 | 34 | M | 438 | 486 | 3 | 24.6 | 1195.56 | 17.9334 | 0.12 | 0.068 |
| 81 | 46 | F | 313 | 426 | 3 | 17.5 | 745.5 | 11.1825 | 0.089 | 0.054 |
| 82 | 38 | F | 438 | 459 | 3 | 24.6 | 1129.14 | 16.9371 | 0.156 | 0.087 |
| 83 | 30 | F | 313 | 507 | 3 | 17.5 | 887.25 | 13.30875 | 0.142 | 0.072 |
| 84 | 29 | F | 438 | 447 | 3 | 24.6 | 1099.62 | 16.4943 | 0.185 | 0.093 |
| 85 | 67 | F | 383 | 47 | 3 | 12.7 | 59.69 | 0.89535 | 0.004 | 0.003 |
| 86 | 52 | F | 396 | 435 | 3 | 19.4 | 843.9 | 12.6585 | 0.09 | 0.058 |
| 87 | 70 | M | 469 | 480 | 5 | 35 | 1680 | 25.2 | 0.086 | 0.063 |
| 88 | 32 | F | 250 | 243 | 3 | 14.1 | 342.63 | 5.13945 | 0.053 | 0.027 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 89 | 76 | F | 313 | 441 | 3 | 19.3 | 851.13 | 12.76695 | 0.037 | 0.031 |
| 90 | 73 | M | 438 | 630 | 3 | 24.6 | 1549.8 | 23.247 | 0.068 | 0.051 |
| 91 | 27 | F | 383 | 96 | 3 | 12.7 | 121.92 | 1.8288 | 0.023 | 0.011 |
| 92 | 77 | M | 383 | 26 | 3 | 12.7 | 33.02 | 0.4953 | 0.001 | 0.001 |
| 93 | 67 | M | 383 | 246 | 3 | 12.7 | 312.42 | 4.6863 | 0.018 | 0.013 |
| 94 | 67 | M | 383 | 56 | 3 | 12.7 | 71.12 | 1.0668 | 0.004 | 0.003 |
| 95 | 32 | M | 354 | 444 | 3 | 19.3 | 856.92 | 12.8538 | 0.087 | 0.049 |
| 96 | 20 | F | 375 | 420 | 3 | 14.1 | 592.2 | 8.883 | 0.146 | 0.068 |
| 97 | 54 | M | 425 | 495 | 3 | 23.2 | 1148.4 | 17.226 | 0.095 | 0.059 |
| 98 | 45 | F | 313 | 263 | 3 | 17.5 | 460.25 | 6.90375 | 0.056 | 0.034 |
| 99 | 55 | M | 354 | 444 | 3 | 19.3 | 856.92 | 12.8538 | 0.069 | 0.044 |
| 100 | 43 | M | 396 | 504 | 3 | 19.4 | 977.76 | 14.6664 | 0.093 | 0.055 |
| 101 | 30 | F | 396 | 408 | 3 | 19.4 | 791.52 | 11.8728 | 0.126 | 0.064 |
| 102 | 62 | M | 354 | 492 | 3 | 19.3 | 949.56 | 14.2434 | 0.065 | 0.043 |
| 103 | 46 | F | 438 | 441 | 3 | 24.6 | 1084.86 | 16.2729 | 0.13 | 0.079 |
| 104 | 36 | F | 354 | 429 | 3 | 19.3 | 827.97 | 12.41955 | 0.119 | 0.065 |
| 105 | 51 | M | 438 | 496 | 3 | 24.6 | 1220.16 | 18.3024 | 0.106 | 0.065 |
| 106 | 36 | M | 354 | 474 | 3 | 19.3 | 914.82 | 13.7223 | 0.091 | 0.052 |
| 107 | 23 | M | 354 | 426 | 3 | 19.3 | 822.18 | 12.3327 | 0.11 | 0.058 |
| 108 | 31 | M | 354 | 420 | 3 | 19.3 | 810.6 | 12.159 | 0.083 | 0.046 |
| 109 | 36 | M | 313 | 432 | 3 | 17.6 | 760.32 | 11.4048 | 0.076 | 0.043 |
| 110 | 37 | M | 354 | 438 | 3 | 19.3 | 845.34 | 12.6801 | 0.084 | 0.048 |
| 111 | 59 | M | 354 | 495 | 3 | 19.3 | 955.35 | 14.33025 | 0.072 | 0.046 |
| 112 | 20 | F | 396 | 405 | 3 | 19.4 | 785.7 | 11.7855 | 0.194 | 0.09 |
| 113 | 38 | M | 396 | 462 | 3 | 19.4 | 896.28 | 13.4442 | 0.088 | 0.051 |
| 114 | 46 | F | 438 | 480 | 3 | 24.6 | 1180.8 | 17.712 | 0.141 | 0.086 |
| 115 | 31 | F | 375 | 438 | 3 | 21 | 919.8 | 13.797 | 0.144 | 0.074 |
| 116 | 79 | M | 396 | 126 | 3 | 19.4 | 244.44 | 3.6666 | 0.007 | 0.006 |
| 117 | 60 | M | 313 | 522 | 3 | 17.6 | 918.72 | 13.7808 | 0.067 | 0.044 |
| 118 | 57 | F | 250 | 525 | 5 | 14.1 | 740.25 | 11.10375 | 0.07 | 0.047 |
| 119 | 33 | F | 383 | 507 | 3 | 12.7 | 643.89 | 9.65835 | 0.098 | 0.051 |
| 120 | 33 | F | 438 | 414 | 3 | 24.6 | 1018.44 | 15.2766 | 0.155 | 0.081 |
| 121 | 69 | F | 354 | 432 | 3 | 19.3 | 833.76 | 12.5064 | 0.053 | 0.041 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 122 | 33 | M | 438 | 497 | 3 | 24.6 | 1222.62 | 18.3393 | 0.124 | 0.07 |
| 123 | 47 | M | 354 | 441 | 3 | 19.3 | 851.13 | 12.76695 | 0.078 | 0.047 |
| 124 | 43 | F | 383 | 411 | 3 | 12.7 | 521.97 | 7.82955 | 0.066 | 0.039 |
| 125 | 39 | F | 494 | 369 | 3 | 27.7 | 1022.13 | 15.33195 | 0.139 | 0.078 |
| 126 | 44 | F | 375 | 453 | 3 | 21 | 951.3 | 14.2695 | 0.118 | 0.07 |
| 127 | 37 | F | 494 | 331 | 3 | 27.7 | 916.87 | 13.75305 | 0.129 | 0.071 |
| 128 | 37 | F | 313 | 67 | 3 | 19.3 | 129.31 | 1.93965 | 0.013 | 0.01 |
| 129 | 27 | F | 494 | 393 | 3 | 27.7 | 1088.61 | 16.32915 | 0.202 | 0.099 |
| 130 | 31 | M | 354 | 471 | 3 | 19.3 | 909.03 | 13.63545 | 0.093 | 0.052 |
| 131 | 40 | F | 438 | 407 | 3 | 24.6 | 1001.22 | 15.0183 | 0.133 | 0.076 |
| 132 | 45 | F | 313 | 279 | 3 | 17.5 | 488.25 | 7.32375 | 0.06 | 0.036 |
| 133 | 48 | M | 313 | 426 | 3 | 17.5 | 745.5 | 11.1825 | 0.067 | 0.041 |
| 134 | 43 | M | 313 | 483 | 3 | 17.5 | 845.25 | 12.67875 | 0.08 | 0.047 |
| 135 | 56 | F | 425 | 471 | 3 | 23.2 | 1092.72 | 16.3908 | 0.106 | 0.071 |
| 136 | 19 | M | 354 | 483 | 3 | 19.3 | 932.19 | 13.98285 | 0.142 | 0.074 |
| 137 | 27 | M | 354 | 456 | 2 | 19.3 | 880.08 | 13.2012 | 0.102 | 0.055 |
| 138 | 36 | F | 313 | 516 | 3 | 17.5 | 903 | 13.545 | 0.13 | 0.071 |
| 139 | 47 | F | 422 | 450 | 5 | 31.7 | 1426.5 | 21.3975 | 0.168 | 0.103 |
| 140 | 32 | F | 313 | 435 | 3 | 17.5 | 761.25 | 11.41875 | 0.118 | 0.061 |
| 141 | 30 | M | 354 | 450 | 3 | 19.3 | 868.5 | 13.0275 | 0.089 | 0.05 |
| 142 | 71 | F | 313 | 429 | 3 | 17.6 | 755.04 | 11.3256 | 0.044 | 0.034 |
| 143 | 48 | F | 271 | 520 | 5 | 17.5 | 910 | 13.65 | 0.105 | 0.065 |
| 144 | 42 | F | 313 | 470 | 5 | 17.5 | 822.5 | 12.3375 | 0.106 | 0.062 |
| 145 | 60 | M | 354 | 486 | 3 | 19.3 | 937.98 | 14.0697 | 0.069 | 0.044 |
| 146 | 33 | M | 313 | 465 | 3 | 17.5 | 813.75 | 12.20625 | 0.082 | 0.046 |
| 147 | 36 | M | 354 | 84 | 2 | 19.3 | 162.12 | 2.4318 | 0.016 | 0.009 |
| 148 | 63 | M | 313 | 510 | 3 | 19.3 | 984.3 | 14.7645 | 0.066 | 0.044 |
| 149 | 38 | M | 354 | 480 | 5 | 19.3 | 926.4 | 13.896 | 0.091 | 0.053 |
| 150 | 59 | F | 438 | 258 | 3 | 24.6 | 634.68 | 9.5202 | 0.057 | 0.04 |
| 151 | 72 | F | 250 | 427 | 3 | 14.1 | 602.07 | 9.03105 | 0.033 | 0.026 |
| 152 | 49 | M | 313 | 429 | 3 | 17.6 | 755.04 | 11.3256 | 0.068 | 0.041 |
| 153 | 49 | M | 354 | 441 | 3 | 19.3 | 851.13 | 12.76695 | 0.076 | 0.046 |
| 154 | 35 | F | 313 | 249 | 3 | 17.6 | 438.24 | 6.5736 | 0.064 | 0.034 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 155 | 48 | F | 469 | 393 | 3 | 35.1 | 1379.43 | 20.69145 | 0.159 | 0.099 |
| 156 | 53 | M | 354 | 462 | 3 | 19.3 | 891.66 | 13.3749 | 0.075 | 0.046 |
| **Jeneen Governmental Hospital** | | | | | | | | | | |
| 157 | 67 | M | 190 | 564 | 5 | 13.49 | 760.836 | 11.41254 | 0.044 | 0.031 |
| 158 | 62 | M | 190 | 214.5 | 5 | 18.99 | 407.3355 | 6.110033 | 0.028 | 0.019 |
| 159 | 73 | F | 190 | 360.5 | 5 | 18.99 | 684.5895 | 10.26884 | 0.036 | 0.029 |
| 160 | 59 | F | 190 | 376.5 | 5 | 26.45 | 995.8425 | 14.93764 | 0.09 | 0.062 |
| 161 | 47 | F | 190 | 408.5 | 5 | 18.99 | 775.7415 | 11.63612 | 0.091 | 0.056 |
| 162 | 58 | F | 190 | 319.5 | 5 | 18.99 | 606.7305 | 9.100958 | 0.056 | 0.038 |
| 163 | 33 | M | 190 | 370 | 5 | 18.99 | 702.63 | 10.53945 | 0.071 | 0.04 |
| 164 | 39 | F | 190 | 410 | 5 | 26.45 | 1084.45 | 16.26675 | 0.147 | 0.083 |
| 165 | 65 | F | 190 | 448.5 | 5 | 26.45 | 1186.283 | 17.79424 | 0.089 | 0.065 |
| 166 | 43 | M | 190 | 405 | 5 | 18.99 | 769.095 | 11.53643 | 0.073 | 0.043 |
| 167 | 25 | F | 190 | 257.5 | 5 | 18.99 | 488.9925 | 7.334888 | 0.099 | 0.046 |
| 168 | 48 | F | 190 | 440 | 5 | 18.99 | 835.56 | 12.5334 | 0.096 | 0.06 |
| 169 | 62 | F | 190 | 311 | 5 | 18.99 | 590.589 | 8.858835 | 0.049 | 0.035 |
| 170 | 26 | M | 190 | 431 | 5 | 18.99 | 818.469 | 12.27704 | 0.099 | 0.053 |
| 171 | 30 | M | 190 | 390 | 5 | 18.99 | 740.61 | 11.10915 | 0.076 | 0.042 |
| 172 | 54 | M | 260 | 447.5 | 5 | 26.45 | 1183.638 | 17.75456 | 0.098 | 0.061 |
| 173 | 24 | F | 190 | 332.5 | 5 | 18.99 | 631.4175 | 9.471263 | 0.134 | 0.064 |
| 174 | 59 | F | 190 | 449 | 5 | 18.99 | 852.651 | 12.78977 | 0.077 | 0.053 |
| 175 | 80 | F | 260 | 450 | 5 | 26.45 | 1190.25 | 17.85375 | 0.038 | 0.034 |
| 176 | 49 | M | 190 | 374.5 | 5 | 18.99 | 711.1755 | 10.66763 | 0.064 | 0.039 |
| 177 | 45 | M | 190 | 485 | 5 | 18.99 | 921.015 | 13.81523 | 0.086 | 0.051 |
| 178 | 39 | F | 260 | 326.5 | 5 | 26.45 | 863.5925 | 12.95389 | 0.117 | 0.066 |
| 179 | 44 | F | 190 | 460 | 5 | 18.99 | 873.54 | 13.1031 | 0.108 | 0.064 |
| 180 | 33 | M | 190 | 488.5 | 5 | 18.99 | 927.6615 | 13.91492 | 0.094 | 0.053 |
| 181 | 54 | M | 190 | 386 | 5 | 18.99 | 733.014 | 10.99521 | 0.061 | 0.038 |
| 182 | 80 | F | 190 | 375.5 | 5 | 18.99 | 713.0745 | 10.69612 | 0.023 | 0.02 |
| 183 | 63 | M | 190 | 485 | 5 | 18.99 | 921.015 | 13.81523 | 0.062 | 0.041 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 184 | 33 | M | 190 | 514.5 | 5 | 18.99 | 977.0355 | 14.65553 | 0.099 | 0.056 |
| 185 | 70 | M | 190 | 448 | 5 | 18.99 | 850.752 | 12.76128 | 0.044 | 0.032 |
| 186 | 56 | F | 190 | 274.5 | 5 | 18.99 | 521.2755 | 7.819133 | 0.051 | 0.034 |
| 187 | 45 | F | 190 | 375 | 5 | 18.99 | 712.125 | 10.68188 | 0.087 | 0.052 |
| 188 | 35 | F | 260 | 450 | 5 | 26.45 | 1190.25 | 17.85375 | 0.174 | 0.094 |
| 189 | 55 | F | 190 | 396.5 | 5 | 18.99 | 752.9535 | 11.2943 | 0.075 | 0.05 |
| 190 | 52 | F | 190 | 425 | 5 | 18.99 | 807.075 | 12.10613 | 0.086 | 0.055 |
| 191 | 69 | F | 190 | 371.5 | 5 | 18.99 | 705.4785 | 10.58218 | 0.045 | 0.035 |
| 192 | 48 | F | 190 | 332.5 | 5 | 18.99 | 631.4175 | 9.471263 | 0.073 | 0.045 |
| 193 | 20 | F | 260 | 280 | 5 | 26.45 | 740.6 | 11.109 | 0.183 | 0.085 |
| 194 | 43 | F | 190 | 397 | 5 | 18.99 | 753.903 | 11.30855 | 0.095 | 0.056 |
| 195 | 56 | M | 190 | 442 | 5 | 18.99 | 839.358 | 12.59037 | 0.042 | 0.042 |
| 196 | 40 | F | 260 | 430.5 | 5 | 26.45 | 1138.673 | 17.08009 | 0.151 | 0.087 |
| 197 | 65 | M | 260 | 443 | 5 | 26.45 | 1171.735 | 17.57603 | 0.073 | 0.05 |
| 198 | 57 | M | 260 | 221 | 5 | 26.45 | 584.545 | 8.768175 | 0.046 | 0.029 |
| 199 | 50 | F | 190 | 340 | 5 | 18.99 | 645.66 | 9.6849 | 0.072 | 0.045 |
| 200 | 68 | F | 190 | 360.5 | 5 | 18.99 | 684.5895 | 10.26884 | 0.046 | 0.034 |
| 201 | 55 | M | 190 | 448 | 5 | 18.99 | 850.752 | 12.76128 | 0.069 | 0.043 |
| 202 | 62 | M | 190 | 409.5 | 5 | 18.99 | 777.6405 | 11.66461 | 0.054 | 0.036 |
| 203 | 53 | M | 190 | 420 | 5 | 18.99 | 797.58 | 11.9637 | 0.067 | 0.042 |
| 204 | 67 | M | 260 | 432 | 5 | 26.45 | 1142.64 | 17.1396 | 0.066 | 0.046 |
| 205 | 35 | F | 190 | 360.5 | 5 | 18.99 | 684.5895 | 10.26884 | 0.1 | 0.054 |
| 206 | 58 | F | 190 | 492.5 | 5 | 18.99 | 935.2575 | 14.02886 | 0.087 | 0.059 |
| 207 | 21 | F | 190 | 455 | 5 | 18.99 | 864.045 | 12.96068 | 0.206 | 0.096 |
| **Palestine Medical Complex** | | | | | | | | | | |
| 208 | 47 | F | 294 | 420 | 3 | 17.28 | 725.76 | 10.8864 | 0.085 | 0.052 |
| 209 | 39 | F | 242 | 427.5 | 3 | 14.22 | 607.905 | 9.118575 | 0.082 | 0.047 |
| 210 | 37 | F | 136 | 237 | 3 | 7.99 | 189.363 | 2.840445 | 0.027 | 0.015 |
| 211 | 74 | M | 141 | 369 | 3 | 8.31 | 306.639 | 4.599585 | 0.013 | 0.01 |
| 212 | 23 | F | 58 | 415.5 | 3 | 9.26 | 384.753 | 5.771295 | 0.085 | 0.04 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 213 | 56 | F | 204 | 441 | 3 | 12.01 | 529.641 | 7.944615 | 0.051 | 0.034 |
| 214 | 59 | F | 166 | 418.5 | 3 | 9.74 | 407.619 | 6.114285 | 0.037 | 0.025 |
| 215 | 34 | F | 146 | 424.5 | 3 | 8.57 | 363.7965 | 5.456948 | 0.054 | 0.029 |
| 216 | 21 | M | 163 | 436.5 | 3 | 9.58 | 418.167 | 6.272505 | 0.059 | 0.031 |
| 217 | 32 | F | 288 | 445.5 | 3 | 16.93 | 754.2315 | 11.31347 | 0.116 | 0.061 |
| 218 | 64 | F | 335 | 302.9 | 3 | 19.72 | 597.3188 | 8.959782 | 0.046 | 0.033 |
| **Al_Ahli Hospital** | | | | | | | | | | |
| 219 | 60 | F | 289 | 444.6 | 0.6 | 13.35 | 593.541 | 8.903115 | 0.052 | 0.036 |
| 220 | 49 | F | 206 | 460.7 | 0.6 | 12.44 | 573.1108 | 8.596662 | 0.065 | 0.041 |
| 221 | 64 | F | 227 | 454.1 | 1.2 | 14.27 | 648.0007 | 9.720011 | 0.05 | 0.036 |
| 222 | 29 | F | 207 | 479.1 | 0.6 | 15.99 | 766.0809 | 11.49121 | 0.129 | 0.065 |
| 223 | 66 | F | 276 | 418.2 | 1.2 | 14.51 | 606.8082 | 9.102123 | 0.044 | 0.032 |
| 224 | 70 | M | 244 | 461.9 | 0.6 | 11.25 | 519.6375 | 7.794563 | 0.027 | 0.019 |
| 225 | 18 | M | 142 | 386.2 | 0.6 | 5.73 | 221.2926 | 3.319389 | 0.035 | 0.018 |
| 226 | 39 | F | 172 | 484.8 | 1.2 | 8.55 | 414.504 | 6.21756 | 0.056 | 0.032 |
| 227 | 73 | M | 139 | 529.2 | 1.2 | 10.62 | 562.0104 | 8.430156 | 0.025 | 0.019 |
| 228 | 44 | F | 137 | 472.7 | 0.6 | 5.73 | 270.8571 | 4.062857 | 0.034 | 0.019 |
| 229 | 59 | M | 279 | 592.6 | 0.6 | 10.76 | 637.6376 | 9.564564 | 0.048 | 0.031 |
| 230 | 39 | F | 203 | 255.8 | 0.6 | 7.2 | 184.176 | 2.76264 | 0.025 | 0.014 |
| 231 | 59 | M | 224 | 551.1 | 0.6 | 10.35 | 570.3885 | 8.555828 | 0.043 | 0.028 |
| 232 | 61 | M | 279 | 551.1 | 1.2 | 19.26 | 1061.419 | 15.92128 | 0.076 | 0.05 |
| 233 | 76 | F | 217 | 433.7 | 0.6 | 12.5 | 542.125 | 8.131875 | 0.024 | 0.02 |
| 234 | 24 | M | 258 | 490.8 | 1.2 | 9.69 | 475.5852 | 7.133778 | 0.061 | 0.033 |
| 235 | 59 | M | 156 | 467.2 | 0.6 | 11.93 | 557.3696 | 8.360544 | 0.042 | 0.027 |
| 236 | 50 | F | 220 | 505.1 | 1.2 | 15.18 | 766.7418 | 11.50113 | 0.085 | 0.054 |
| 237 | 30 | M | 166 | 536.6 | 1.2 | 11.46 | 614.9436 | 9.224154 | 0.063 | 0.035 |
| 238 | 74 | F | 234 | 511.3 | 1.2 | 12.08 | 617.6504 | 9.264756 | 0.031 | 0.025 |
| 239 | 28 | M | 105 | 490.2 | 0.6 | 8.03 | 393.6306 | 5.904459 | 0.044 | 0.024 |
| 240 | 18 | F | 152 | 419.8 | 0.6 | 5.62 | 235.9276 | 3.538914 | 0.064 | 0.029 |
| 241 | 66 | M | 279 | 214.6 | 0.6 | 29.89 | 641.4394 | 9.621591 | 0.039 | 0.027 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 242 | 75 | M | 110 | 170.2 | 0.6 | 12.6 | 214.452 | 3.21678 | 0.008 | 0.006 |
| 243 | 73 | M | 200 | 525.1 | 0.6 | 15.44 | 810.7544 | 12.16132 | 0.036 | 0.027 |
| 244 | 60 | M | 120 | 143.2 | 0.6 | 13.74 | 196.7568 | 2.951352 | 0.014 | 0.009 |
| 245 | 27 | F | 227 | 214.6 | 0.6 | 15.7 | 336.922 | 5.05383 | 0.063 | 0.031 |
| 246 | 50 | M | 152 | 452.6 | 0.6 | 10.52 | 476.1352 | 7.142028 | 0.042 | 0.026 |
| 247 | 28 | M | 165 | 472.1 | 0.6 | 11.41 | 538.6661 | 8.079992 | 0.06 | 0.033 |
| 248 | 33 | M | 145 | 482.8 | 0.6 | 7.19 | 347.1332 | 5.206998 | 0.035 | 0.02 |
| 249 | 41 | M | 160 | 533.6 | 0.6 | 12.36 | 659.5296 | 9.892944 | 0.064 | 0.037 |
| 250 | 28 | M | 149 | 535 | 1.2 | 7.5 | 401.25 | 6.01875 | 0.045 | 0.025 |
| 251 | 34 | M | 112 | 471.2 | 0.6 | 7.75 | 365.18 | 5.4777 | 0.037 | 0.021 |
| 252 | 48 | F | 151 | 533.7 | 1.2 | 11.54 | 615.8898 | 9.238347 | 0.043 | 0.044 |
| 253 | 38 | F | 103 | 499.8 | 1.2 | 7.25 | 362.355 | 5.435325 | 0.05 | 0.028 |
| 254 | 40 | F | 122 | 419.1 | 0.6 | 5.64 | 236.3724 | 3.545586 | 0.031 | 0.018 |
| 255 | 68 | F | 224 | 423.6 | 1.2 | 23.07 | 977.2452 | 14.65868 | 0.065 | 0.049 |
| 256 | 54 | F | 258 | 468.2 | 0.6 | 21.59 | 1010.844 | 15.16266 | 0.103 | 0.067 |
| 257 | 32 | F | 269 | 385.7 | 0.6 | 11.81 | 455.5117 | 6.832676 | 0.07 | 0.037 |
| 258 | 61 | M | 279 | 555.1 | 1.2 | 19.26 | 1069.123 | 16.03684 | 0.076 | 0.05 |
| 259 | 72 | M | 241 | 600.6 | 0.6 | 16.67 | 1001.2 | 15.018 | 0.046 | 0.035 |
| 260 | 67 | F | 186 | 428.7 | 0.6 | 8.17 | 350.2479 | 5.253719 | 0.024 | 0.018 |
| 261 | 44 | M | 110 | 506.1 | 1.2 | 7.59 | 384.1299 | 5.761949 | 0.036 | 0.021 |
| 262 | 55 | F | 275 | 475.3 | 1.2 | 19.37 | 920.6561 | 13.80984 | 0.092 | 0.061 |
| 263 | 28 | M | 149 | 535 | 1.2 | 7.5 | 401.25 | 6.01875 | 0.045 | 0.025 |
| 264 | 58 | M | 161 | 489.3 | 1.2 | 16.9 | 826.917 | 12.40376 | 0.063 | 0.041 |
| 265 | 20 | F | 109 | 429.3 | 0.6 | 5.79 | 248.5647 | 3.728471 | 0.061 | 0.028 |
| 266 | 34 | M | 112 | 471.1 | 0.6 | 7.75 | 365.1025 | 5.476538 | 0.037 | 0.021 |
| 267 | 38 | M | 231 | 562.7 | 1.2 | 22.31 | 1255.384 | 18.83076 | 0.123 | 0.071 |
| 268 | 65 | F | 200 | 436.1 | 0.6 | 10.31 | 449.6191 | 6.744287 | 0.034 | 0.024 |
| 269 | 49 | F | 101 | 420.2 | 0.6 | 7.72 | 324.3944 | 4.865916 | 0.037 | 0.023 |
| 270 | 59 | F | 124 | 409.1 | 1.2 | 6.82 | 279.0062 | 4.185093 | 0.025 | 0.017 |
| 271 | 75 | F | 303 | 484.1 | 1.2 | 17.04 | 824.9064 | 12.3736 | 0.039 | 0.031 |
| 272 | 25 | F | 182 | 496 | 0.6 | 6.21 | 308.016 | 4.62024 | 0.063 | 0.03 |
| 273 | 49 | M | 95 | 108.7 | 0.6 | 10.88 | 118.2656 | 1.773984 | 0.011 | 0.006 |
| 274 | 46 | M | 207 | 486.3 | 0.6 | 11 | 534.93 | 8.02395 | 0.049 | 0.029 |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| 275 | 24 | M | 210 | 468.3 | 0.6 | 10.41 | 487.5003 | 7.312505 | 0.063 | 0.034 |
| 276 | 38 | F | 154 | 382.1 | 1.2 | 9.68 | 369.8728 | 5.548092 | 0.054 | 0.029 |
| 277 | 47 | M | 111 | 475.3 | 0.6 | 6.14 | 291.8342 | 4.377513 | 0.027 | 0.016 |
| 278 | 35 | F | 224 | 203.7 | 0.6 | 14.03 | 285.7911 | 4.286867 | 0.042 | 0.023 |
| 279 | 38 | F | 141 | 347.6 | 0.6 | 9.75 | 338.91 | 5.08365 | 0.047 | 0.026 |
| 280 | 61 | F | 207 | 472.7 | 1.2 | 12.17 | 575.2759 | 8.629139 | 0.049 | 0.035 |
| 281 | 58 | F | 129 | 433.6 | 0.6 | 8.92 | 386.7712 | 5.801568 | 0.036 | 0.024 |
| 282 | 61 | M | 255 | 553.7 | 0.6 | 15.98 | 884.8126 | 13.27219 | 0.063 | 0.053 |
| 283 | 25 | F | 165 | 526.6 | 1.2 | 6.8 | 358.088 | 5.37132 | 0.073 | 0.035 |
| 284 | 54 | M | 154 | 569.3 | 1.2 | 5.79 | 329.6247 | 4.944371 | 0.027 | 0.017 |
| 285 | 64 | M | 79 | 404.2 | 0.6 | 6.04 | 244.1368 | 3.662052 | 0.016 | 0.011 |
| 286 | 37 | F | 109 | 445.4 | 0.6 | 6.71 | 298.8634 | 4.482951 | 0.042 | 0.023 |
| 287 | 46 | F | 275 | 447.8 | 0.6 | 10.16 | 454.9648 | 6.824472 | 0.054 | 0.033 |
| 288 | 46 | F | 127 | 456.8 | 1.2 | 13.33 | 608.9144 | 9.133716 | 0.073 | 0.044 |
| 289 | 20 | M | 91 | 503.2 | 0.6 | 6.96 | 350.2272 | 5.253408 | 0.051 | 0.027 |
| 290 | 67 | M | 286 | 510.6 | 1.2 | 16.08 | 821.0448 | 12.31567 | 0.048 | 0.033 |
| 291 | 25 | M | 62 | 407.7 | 0.6 | 4.74 | 193.2498 | 2.898747 | 0.024 | 0.013 |
| 292 | 53 | F | 207 | 461.2 | 0.6 | 17.85 | 823.242 | 12.34863 | 0.086 | 0.056 |
| 293 | 50 | F | 186 | 422.2 | 0.6 | 21.3 | 899.286 | 13.48929 | 0.1 | 0.063 |
| 294 | 35 | M | 272 | 523.6 | 1.2 | 17.1 | 895.356 | 13.43034 | 0.09 | 0.051 |
| 295 | 24 | M | 151 | 494.1 | 0.6 | 10.45 | 516.3345 | 7.745018 | 0.067 | 0.036 |
| 296 | 67 | F | 200 | 467.3 | 1.2 | 21 | 981.33 | 14.71995 | 0.068 | 0.051 |
| 297 | 80 | F | 107 | 495.2 | 0.6 | 8.18 | 405.0736 | 6.076104 | 0.013 | 0.012 |
| 298 | 52 | M | 192 | 529.6 | 0.6 | 8.87 | 469.7552 | 7.046328 | 0.04 | 0.025 |
| 299 | 45 | F | 89 | 425.2 | 0.6 | 6.81 | 289.5612 | 4.343418 | 0.035 | 0.021 |
| 300 | 48 | M | 229 | 509.1 | 0.6 | 15.84 | 806.4144 | 12.09622 | 0.073 | 0.044 |
| 301 | 30 | F | 172 | 452.1 | 0.6 | 11.9 | 537.999 | 8.069985 | 0.086 | 0.044 |
| 302 | 40 | M | 95 | 489.3 | 1.2 | 5.74 | 280.8582 | 4.212873 | 0.027 | 0.016 |
| 303 | 61 | F | 175 | 414.2 | 0.6 | 13.38 | 554.1996 | 8.312994 | 0.047 | 0.033 |
| 304 | 28 | F | 96 | 406.7 | 0.6 | 7.34 | 298.5178 | 4.477767 | 0.053 | 0.026 |
| 305 | 30 | F | 269 | 234.2 | 0.6 | 11.26 | 263.7092 | 3.955638 | 0.042 | 0.021 |
| 306 | 50 | F | 215 | 450.6 | 1.2 | 20.25 | 912.465 | 13.68698 | 0.101 | 0.064 |
| 307 | 30 | M | 74 | 436.8 | 1.2 | 7.77 | 339.3936 | 5.090904 | 0.035 | 0.019 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 308 | 56 | F | 213 | 472.1 | 0.6 | 10.38 | 490.0398 | 7.350597 | 0.048 | 0.032 |
| 309 | 37 | M | 165 | 512.2 | 0.6 | 8.92 | 456.8824 | 6.853236 | 0.039 | 0.026 |
| 310 | 37 | M | 207 | 502.1 | 0.6 | 10.68 | 536.2428 | 8.043642 | 0.046 | 0.03 |
| 311 | 72 | M | 255 | 520.2 | 0.6 | 10.76 | 559.7352 | 8.396028 | 0.026 | 0.019 |
| 312 | 52 | M | 82 | 463.2 | 0.6 | 6.27 | 290.4264 | 4.356396 | 0.012 | 0.015 |
| 313 | 40 | F | 86 | 549.4 | 1.2 | 4.01 | 220.3094 | 3.304641 | 0.029 | 0.017 |
| 314 | 76 | M | 171 | 484.1 | 0.6 | 12.48 | 604.1568 | 9.062352 | 0.022 | 0.017 |
| 315 | 72 | M | 105 | 466.2 | 0.6 | 12.02 | 560.3724 | 8.405586 | 0.026 | 0.019 |
| 316 | 46 | F | 195 | 505.6 | 0.6 | 13.49 | 682.0544 | 10.23082 | 0.082 | 0.05 |
| 317 | 66 | F | 110 | 452.4 | 0.6 | 15.22 | 688.5528 | 10.32829 | 0.05 | 0.037 |
| 318 | 28 | M | 105 | 490.2 | 0.6 | 8.03 | 393.6306 | 5.904459 | 0.044 | 0.024 |
| 319 | 61 | M | 279 | 555.1 | 1.2 | 19.26 | 1069.123 | 16.03684 | 0.076 | 0.05 |
| 320 | 30 | M | 166 | 536.6 | 1.2 | 11.46 | 614.9436 | 9.224154 | 0.063 | 0.035 |
| 321 | 59 | M | 156 | 467.2 | 0.6 | 11.93 | 557.3696 | 8.360544 | 0.042 | 0.027 |
| 322 | 28 | M | 165 | 472.1 | 0.6 | 11.41 | 538.6661 | 8.079992 | 0.06 | 0.033 |
| **Istishari Arab Hospital** | | | | | | | | | | |
| 323 | 32 | M | 328 | 510 | 1.5 | 21.3 | 1086.3 | 16.2945 | 0.111 | 0.062 |
| 324 | 29 | M | 322 | 671 | 1.5 | 21.1 | 1415.81 | 21.23715 | 0.152 | 0.084 |
| 325 | 61 | M | 349 | 1071 | 1 | 22.9 | 2452.59 | 36.78885 | 0.175 | 0.115 |
| 326 | 80 | F | 269 | 628 | 1.5 | 17.6 | 1105.28 | 16.5792 | 0.035 | 0.032 |
| 327 | 27 | F | 294 | 474 | 1.5 | 19.3 | 914.82 | 13.7223 | 0.17 | 0.058 |
| 328 | 28 | M | 331 | 512 | 1.5 | 21.8 | 1116.16 | 16.7424 | 0.125 | 0.068 |
| 329 | 57 | M | 337 | 552 | 1.5 | 22.1 | 1219.92 | 18.2988 | 0.095 | 0.061 |
| 330 | 69 | M | 315 | 506 | 3 | 20.7 | 1047.42 | 15.7113 | 0.059 | 0.04 |
| 331 | 26 | M | 334 | 519 | 1.5 | 21.8 | 1131.42 | 16.9713 | 0.136 | 0.073 |
| 332 | 22 | M | 342 | 538 | 1.5 | 22.5 | 1210.5 | 18.1575 | 0.167 | 0.088 |
| 333 | 35 | M | 238 | 166 | 3 | 15.7 | 260.62 | 3.9093 | 0.026 | 0.015 |
| 334 | 69 | F | 277 | 392 | 1.5 | 18.2 | 713.44 | 10.7016 | 0.046 | 0.035 |
| 335 | 28 | F | 307 | 672 | 1.5 | 20.1 | 1350.72 | 20.2608 | 0.239 | 0.119 |
| 336 | 54 | M | 324 | 630 | 1.5 | 21.3 | 1341.9 | 20.1285 | 0.111 | 0.069 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 337 | 34 | M | 328 | 165 | 3 | 21.6 | 356.4 | 5.346 | 0.036 | 0.02 |
| 338 | 50 | F | 338 | 441 | 1.5 | 22.3 | 983.43 | 14.75145 | 0.087 | 0.069 |
| 339 | 49 | M | 296 | 558 | 1.5 | 19.4 | 1082.52 | 16.2378 | 0.097 | 0.059 |
| 340 | 21 | M | 169 | 468 | 1.5 | 11 | 514.8 | 7.722 | 0.073 | 0.038 |
| 341 | 51 | M | 321 | 688 | 1.5 | 21.1 | 1451.68 | 21.7752 | 0.126 | 0.078 |
| 342 | 27 | F | 217 | 141 | 3 | 14.3 | 201.63 | 3.02445 | 0.037 | 0.018 |
| 343 | 28 | M | 302 | 463 | 1.5 | 20 | 926 | 13.89 | 0.096 | 0.057 |
| 344 | 33 | F | 317 | 165 | 3 | 20.8 | 343.2 | 5.148 | 0.052 | 0.027 |
| 345 | 41 | M | 349 | 501 | 1.5 | 33.9 | 1698.39 | 25.47585 | 0.164 | 0.096 |
| 346 | 24 | M | 308 | 515 | 1.5 | 20.2 | 1040.3 | 15.6045 | 0.134 | 0.072 |
| 347 | 31 | M | 271 | 501 | 1.5 | 17.8 | 891.78 | 13.3767 | 0.091 | 0.051 |
| 348 | 45 | M | 347 | 551 | 1.5 | 22.9 | 1261.79 | 18.92685 | 0.117 | 0.07 |
| 349 | 37 | M | 229 | 498 | 1.5 | 15 | 747 | 11.205 | 0.074 | 0.042 |
| 350 | 61 | F | 347 | 141 | 3 | 22.9 | 322.89 | 4.84335 | 0.028 | 0.019 |
| 351 | 35 | F | 311 | 522 | 1.5 | 22.5 | 1174.5 | 17.6175 | 0.172 | 0.092 |
| 352 | 56 | F | 332 | 161 | 3 | 21.8 | 350.98 | 5.2647 | 0.034 | 0.023 |
| 353 | 49 | M | 317 | 517 | 1.5 | 20.8 | 1075.36 | 16.1304 | 0.096 | 0.058 |
| 354 | 46 | M | 300 | 800 | 1.5 | 19.7 | 1576 | 23.64 | 0.145 | 0.087 |
| 355 | 45 | M | 347 | 189 | 3 | 22.9 | 432.81 | 6.49215 | 0.04 | 0.024 |
| 356 | 41 | M | 293 | 499 | 1.5 | 28.4 | 1417.16 | 21.2574 | 0.137 | 0.08 |
| 357 | 68 | M | 327 | 190 | 3 | 21.4 | 406.6 | 6.099 | 0.023 | 0.016 |
| 358 | 37 | M | 232 | 531 | 1.5 | 15.1 | 801.81 | 12.02715 | 0.079 | 0.045 |
| 359 | 33 | M | 347 | 522 | 1.5 | 22.9 | 1195.38 | 17.9307 | 0.121 | 0.068 |
| 360 | 23 | M | 331 | 516 | 1.5 | 21.7 | 1119.72 | 16.7958 | 0.149 | 0.079 |
| 361 | 37 | F | 337 | 191 | 5 | 22.2 | 424.02 | 6.3603 | 0.06 | 0.033 |
| 362 | 38 | F | 298 | 148 | 3 | 19.5 | 288.6 | 4.329 | 0.041 | 0.022 |
| 363 | 38 | F | 293 | 455 | 1.5 | 19.2 | 873.6 | 13.104 | 0.121 | 0.067 |
| 364 | 50 | M | 347 | 523 | 1.5 | 22.8 | 1192.44 | 17.8866 | 0.106 | 0.064 |
| 365 | 19 | M | 275 | 467 | 1.5 | 18.2 | 849.94 | 12.7491 | 0.13 | 0.067 |
| 366 | 64 | M | 331 | 495 | 1.5 | 21.8 | 1079.1 | 16.1865 | 0.07 | 0.047 |
| 367 | 50 | M | 339 | 501 | 1.5 | 22.3 | 1117.23 | 16.75845 | 0.1 | 0.06 |
| 368 | 21 | M | 176 | 490 | 1.5 | 11.5 | 563.5 | 8.4525 | 0.08 | 0.042 |
| 369 | 46 | M | 349 | 490 | 1.5 | 22.9 | 1122.1 | 16.8315 | 0.103 | 0.062 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 370 | 18 | M | 219 | 759 | 1.5 | 14.4 | 1092.96 | 16.3944 | 0.174 | 0.09 |
| 371 | 66 | M | 347 | 498 | 1.5 | 33.8 | 1683.24 | 25.2486 | 0.101 | 0.07 |
| 372 | 49 | M | 347 | 455 | 1 | 13.7 | 623.35 | 9.35025 | 0.056 | 0.034 |
| 373 | 58 | M | 320 | 695 | 1.5 | 21.1 | 1466.45 | 21.99675 | 0.112 | 0.072 |
| 374 | 62 | M | 334 | 564 | 1.5 | 22 | 1240.8 | 18.612 | 0.086 | 0.057 |
| 375 | 36 | M | 290 | 516 | 1.5 | 19.1 | 985.56 | 14.7834 | 0.098 | 0.056 |
| 376 | 68 | M | 348 | 523 | 1.5 | 22.9 | 1197.67 | 17.96505 | 0.066 | 0.047 |
| 377 | 78 | F | 338 | 455 | 1.5 | 22.2 | 1010.1 | 15.1515 | 0.038 | 0.033 |
| 378 | 60 | F | 348 | 529 | 1.5 | 22.9 | 1211.41 | 18.17115 | 0.106 | 0.074 |
| 379 | 33 | M | 322 | 678 | 1.5 | 21.1 | 1430.58 | 21.4587 | 0.145 | 0.082 |
| 380 | 57 | M | 323 | 655 | 1.5 | 21.2 | 1388.6 | 20.829 | 0.108 | 0.069 |
| 381 | 72 | M | 325 | 569 | 1 | 21.4 | 1217.66 | 18.2649 | 0.056 | 0.042 |
| 382 | 33 | M | 286 | 683 | 1.5 | 18.8 | 1284.04 | 19.2606 | 0.13 | 0.073 |
| 383 | 29 | M | 300 | 166 | 3 | 19.8 | 328.68 | 4.9302 | 0.035 | 0.019 |
| 384 | 52 | F | 345 | 470 | | 22.7 | 1066.9 | 16.0035 | 0.113 | 0.073 |
| 385 | 55 | M | 322 | 170 | 3 | 21.3 | 362.1 | 5.4315 | 0.029 | 0.018 |
| 386 | 21 | F | 285 | 497 | 1.5 | 18.7 | 929.39 | 13.94085 | 0.221 | 0.103 |
| 387 | 70 | M | 279 | 429 | 1.5 | 18.3 | 785.07 | 11.77605 | 0.04 | 0.029 |
| 388 | 21 | F | 208 | 163 | 3 | 13.7 | 223.31 | 3.34965 | 0.053 | 0.025 |
| 389 | 19 | M | 326 | 608 | 1.5 | 21.4 | 1301.12 | 19.5168 | 0.199 | 0.103 |
| 390 | 45 | M | 317 | 381 | 1.5 | 20.9 | 796.29 | 11.94435 | 0.074 | 0.044 |
| 391 | 24 | F | 231 | 597 | 1.5 | 15 | 895.5 | 13.4325 | 0.19 | 0.091 |
| 392 | 59 | M | 263 | 184 | 3 | 17.2 | 316.48 | 4.7472 | 0.024 | 0.015 |
| 393 | 70 | F | 278 | 168 | 3 | 18.1 | 304.08 | 4.5612 | 0.019 | 0.011 |
| 394 | 58 | F | 272 | 488 | 1.5 | 17.8 | 868.64 | 13.0296 | 0.08 | 0.055 |
| 395 | 46 | M | 310 | 202 | 3 | 20.4 | 412.08 | 6.1812 | 0.038 | 0.023 |
| 396 | 51 | M | 347 | 189 | 1.5 | 22.8 | 430.92 | 6.4638 | 0.038 | 0.023 |
| 397 | 64 | F | 272 | 407 | 1.5 | 17.8 | 724.46 | 10.8669 | 0.056 | 0.04 |
| 398 | 31 | M | 305 | 497 | 1.5 | 20 | 994 | 14.91 | 0.102 | 0.057 |
| 399 | 29 | M | 300 | 166 | 1.5 | 19.8 | 328.68 | 4.9302 | 0.035 | 0.019 |
| 400 | 33 | M | 324 | 650 | 1.5 | 21.2 | 1378 | 20.67 | 0.139 | 0.079 |
| 401 | 34 | F | 329 | 577 | 1.5 | 21.6 | 1246.32 | 18.6948 | 0.186 | 0.099 |
| 402 | 32 | F | 331 | 458 | 1.5 | 21.7 | 993.86 | 14.9079 | 0.153 | 0.08 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 403 | 36 | M | 299 | 482 | 1.5 | 19.6 | 944.72 | 14.1708 | 0.094 | 0.054 |
| 404 | 53 | F | 333 | 530 | 1.5 | 21.9 | 1160.7 | 17.4105 | 0.121 | 0.079 |
| 405 | 41 | M | 263 | 176 | 3 | 17.3 | 304.48 | 4.5672 | 0.029 | 0.017 |
| 406 | 56 | F | 343 | 538 | 1.5 | 22.5 | 1210.5 | 18.1575 | 0.118 | 0.079 |
| 407 | 33 | M | 266 | 531 | 1.5 | 17.5 | 929.25 | 13.93875 | 0.094 | 0.053 |
| 408 | 58 | M | 346 | 509 | 1.5 | 22.7 | 1155.43 | 17.33145 | 0.088 | 0.057 |
| 409 | 60 | M | 286 | 607 | 1.5 | 18.9 | 1147.23 | 17.20845 | 0.084 | 0.055 |
| 410 | 53 | M | 348 | 564 | 1.5 | 33.9 | 1911.96 | 28.6794 | 0.161 | 0.1 |
| 411 | 18 | F | 234 | 460 | 1.5 | 15.4 | 708.4 | 10.626 | 0.193 | 0.087 |
| 412 | 54 | M | 267 | 162 | 3 | 17.5 | 283.5 | 4.2525 | 0.023 | 0.015 |
| **Al_Razi Hospital** | | | | | | | | | | |
| 413 | 54 | M | 297 | 485 | 5 | 19.6 | 950.6 | 14.259 | 0.078 | 0.049 |
| 414 | 23 | M | 173 | 483 | 5 | 11.3 | 545.79 | 8.18685 | 0.073 | 0.039 |
| 415 | 28 | M | 288 | 473 | 5 | 18.7 | 884.51 | 13.26765 | 0.099 | 0.054 |
| 416 | 20 | M | 364 | 452 | 5 | 23.9 | 1080.28 | 16.2042 | 0.158 | 0.083 |
| 417 | 60 | F | 431 | 422 | 5 | 28.1 | 1185.82 | 17.7873 | 0.104 | 0.073 |
| 418 | 22 | F | 280 | 447 | 5 | 18.2 | 813.54 | 12.2031 | 0.187 | 0.088 |
| 419 | 42 | F | 581 | 457 | 5 | 38.1 | 1741.17 | 26.11755 | 0.224 | 0.13 |
| 420 | 20 | M | 454 | 562 | 5 | 29.7 | 1669.14 | 25.0371 | 0.245 | 0.128 |
| 421 | 34 | F | 468 | 488 | 5 | 30.5 | 1488.4 | 22.326 | 0.222 | 0.118 |
| 422 | 32 | M | 289 | 502 | 5 | 19 | 953.8 | 14.307 | 0.097 | 0.054 |
| 423 | 23 | M | 295 | 493 | 5 | 19.2 | 946.56 | 14.1984 | 0.126 | 0.067 |
| 424 | 20 | M | 161 | 437 | 5 | 10.5 | 458.85 | 6.88275 | 0.067 | 0.035 |
| 425 | 70 | M | 307 | 425 | 5 | 20.2 | 858.5 | 12.8775 | 0.044 | 0.032 |
| 426 | 44 | M | 333 | 495 | 5 | 21.8 | 1079.1 | 16.1865 | 0.101 | 0.06 |
| 427 | 55 | F | 404 | 475 | 5 | 26.5 | 1258.75 | 18.88125 | 0.125 | 0.083 |
| 428 | 79 | M | 230 | 483 | 5 | 15.1 | 729.33 | 10.93995 | 0.021 | 0.018 |
| 429 | 67 | F | 647 | 434 | 5 | 42.6 | 1848.84 | 27.7326 | 0.128 | 0.096 |
| 430 | 69 | M | 464 | 512 | 5 | 30.3 | 1551.36 | 23.2704 | 0.087 | 0.06 |
| 431 | 32 | F | 321 | 448 | 5 | 21.2 | 949.76 | 14.2464 | 0.147 | 0.076 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 432 | 22 | M | 191 | 482 | 5 | 12.4 | 597.68 | 8.9652 | 0.082 | 0.044 |
| 433 | 76 | F | 271 | 423 | 5 | 17.8 | 752.94 | 11.2941 | 0.033 | 0.027 |
| 434 | 54 | F | 688 | 518 | 5 | 45 | 2331 | 34.965 | 0.237 | 0.156 |
| 435 | 19 | F | 156 | 480 | 5 | 10.2 | 489.6 | 7.344 | 0.127 | 0.058 |

# APPENDIX B

Table B.1: Effective dose parameters in abdomen and pelvis CT-examinations for each patient**.**

**Worksheet**

**Patient ID …………..** **Hospital ………………….**

**Age …………………..** **Sex ……………………….**

| **Parameter** | **Value** |
|---|---|
| Tube potential (kVp) | |
| MAs | |
| Slice thickness (mm) | |
| Scan length | |
| DLP | |
| CTDIv or CTDIw | |

# APPENDIX B

Table B.2: Effective dose and lifetime cancer risk assessment in abdomen and pelvis CT-examinations.

| Pt ID | Pt age | Pt sex | mAs | Scan length | T | CTDIv | DLP | ED For abd ct | ED For pelvis ct | ED For abd& pelvis ct | LAR of cancer incidence (%) | LAR of cancer mortality (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

# APPENDIX C

Table C.1: Lifetime attributable risk of cancer Incidence for adults male.

| **Age at Exposure** | **All Cancers** |
|---|---|
| 18 | 1059 |
| 19 | 1018 |
| 20 | 977 |
| 21 | 947.9 |
| 22 | 918.8 |
| 23 | 889.7 |
| 24 | 860.6 |
| 25 | 831.5 |
| 26 | 802.4 |
| 27 | 773.3 |
| 28 | 744.2 |
| 29 | 715.1 |
| 30 | 686 |
| 31 | 682.2 |
| 32 | 678.4 |
| 33 | 674.6 |
| 34 | 670.8 |
| 35 | 667 |
| 36 | 663.2 |
| 37 | 659.4 |
| 38 | 655.6 |
| 39 | 651.8 |
| 40 | 648 |
| 41 | 642.3 |
| 42 | 636.6 |
| 43 | 630.9 |
| 44 | 625.2 |
| 45 | 619.5 |
| 46 | 613.8 |
| 47 | 608.1 |
| 48 | 602.4 |
| 49 | 596.7 |
| 50 | 591 |
| 51 | 580.8 |
| 52 | 570.6 |
| 53 | 560.4 |
| 54 | 550.2 |
| 55 | 540 |
| 56 | 529.8 |

| | |
|---|---|
| 57 | 519.6 |
| 58 | 509.4 |
| 59 | 499.2 |
| 60 | 489 |
| 61 | 474.4 |
| 62 | 459.8 |
| 63 | 445.2 |
| 64 | 430.6 |
| 65 | 416 |
| 66 | 401.4 |
| 67 | 386.8 |
| 68 | 372.2 |
| 69 | 375.6 |
| 70 | 343 |
| 71 | 326.1 |
| 72 | 309.2 |
| 73 | 292.3 |
| 74 | 275.4 |
| 75 | 258.5 |
| 76 | 241.4 |
| 77 | 224.7 |
| 78 | 207.8 |
| 79 | 190.9 |
| 80 | 174 |

Table C.2: Lifetime attributable risk of cancer Incidence for adults female

| **Age at Exposure** | **All Cancers** |
|---|---|
| 18 | 1813.2 |
| 19 | 1729.6 |
| 20 | 1646 |
| 21 | 1587.9 |
| 22 | 1529.8 |
| 23 | 1471.7 |
| 24 | 1413.6 |
| 25 | 1355.5 |
| 26 | 1297.4 |
| 27 | 1239.3 |
| 28 | 1181.2 |
| 29 | 1123.1 |
| 30 | 1065 |
| 31 | 1047.1 |
| 32 | 1029.2 |
| 33 | 1011.3 |
| 34 | 993.4 |
| 35 | 975.5 |
| 36 | 957.6 |
| 37 | 939.7 |
| 38 | 921.8 |
| 39 | 903.9 |
| 40 | 886 |
| 41 | 871.4 |
| 42 | 856.8 |
| 43 | 842.2 |
| 44 | 827.6 |
| 45 | 813 |
| 46 | 798.4 |
| 47 | 783.8 |
| 48 | 769.2 |
| 49 | 754.6 |
| 50 | 740 |
| 51 | 724.6 |
| 52 | 709.2 |
| 53 | 693.8 |
| 54 | 678.4 |
| 55 | 663 |
| 56 | 647.6 |
| 57 | 632.2 |
| 58 | 616.8 |
| 59 | 601.4 |
| 60 | 586 |

| | |
|---|---|
| 61 | 568.3 |
| 62 | 550.6 |
| 63 | 532.9 |
| 64 | 515.2 |
| 65 | 497.5 |
| 66 | 479.8 |
| 67 | 462.1 |
| 68 | 444.4 |
| 69 | 426.7 |
| 70 | 409 |
| 71 | 389.5 |
| 72 | 370 |
| 73 | 350.5 |
| 74 | 331 |
| 75 | 311.5 |
| 76 | 292 |
| 77 | 272.5 |
| 78 | 253 |
| 79 | 233.5 |
| 80 | 214 |

# APPENDIX D

Table D.1: Lifetime attributable risk of cancer mortality for adults Male.

| **Age at Exposure** | **All Cancers** |
|---|---|
| 18 | 547.8 |
| 19 | 529.4 |
| 20 | 511 |
| 21 | 498 |
| 22 | 485 |
| 23 | 472 |
| 24 | 459 |
| 25 | 446 |
| 26 | 433 |
| 27 | 420 |
| 28 | 407 |
| 29 | 394 |
| 30 | 381 |
| 31 | 380.2 |
| 32 | 380.2 |
| 33 | 379.8 |
| 34 | 379.4 |
| 35 | 379 |
| 36 | 378.6 |
| 37 | 378.2 |
| 38 | 377.8 |
| 39 | 377.4 |
| 40 | 377 |
| 41 | 375.3 |
| 42 | 373.6 |
| 43 | 371.9 |
| 44 | 370.2 |
| 45 | 368.5 |
| 46 | 366.8 |
| 47 | 365.1 |
| 48 | 363.4 |
| 49 | 361.7 |
| 50 | 360 |
| 51 | 355.9 |
| 52 | 351.8 |
| 53 | 347.7 |
| 54 | 343.6 |
| 55 | 339.5 |

| | |
|---|---|
| 56 | 335.4 |
| 57 | 331.3 |
| 58 | 327.2 |
| 59 | 323.1 |
| 60 | 319 |
| 61 | 312.1 |
| 62 | 305.2 |
| 63 | 298.3 |
| 64 | 291.4 |
| 65 | 284.5 |
| 66 | 277.6 |
| 67 | 270.7 |
| 68 | 263.8 |
| 69 | 256.9 |
| 70 | 250 |
| 71 | 240.3 |
| 72 | 230.6 |
| 73 | 220.9 |
| 74 | 211.2 |
| 75 | 201.5 |
| 76 | 191.8 |
| 77 | 182.1 |
| 78 | 172.4 |
| 79 | 162.7 |
| 80 | 153 |

Table D.2: Lifetime attributable risk of cancer mortality for adults female.

mortality for adults female

| Age at Exposure | All Cancers |
|---|---|
| 18 | 822.8 |
| 19 | 792.4 |
| 20 | 762 |
| 21 | 740 |
| 22 | 718 |
| 23 | 696 |
| 24 | 674 |
| 25 | 652 |
| 26 | 630 |
| 27 | 608 |
| 28 | 586 |
| 29 | 564 |
| 30 | 542 |
| 31 | 538.5 |
| 32 | 535 |
| 33 | 531.5 |
| 34 | 528 |
| 35 | 524.5 |
| 36 | 521 |
| 37 | 517.5 |
| 38 | 514 |
| 39 | 510.5 |
| 40 | 507 |
| 41 | 503.2 |
| 42 | 499.4 |
| 43 | 495.6 |
| 44 | 491.8 |
| 45 | 488 |
| 46 | 484.2 |
| 47 | 480.4 |
| 48 | 476.6 |
| 49 | 472.8 |
| 50 | 469 |
| 51 | 463 |
| 52 | 457 |
| 53 | 451 |
| 54 | 445 |
| 55 | 439 |
| 56 | 433 |
| 57 | 427 |

| | |
|---|---|
| 58 | 421 |
| 59 | 415 |
| 60 | 409 |
| 61 | 399.8 |
| 62 | 390.6 |
| 63 | 381.4 |
| 64 | 372.2 |
| 65 | 363 |
| 66 | 353.8 |
| 67 | 344.6 |
| 68 | 335.4 |
| 69 | 326.2 |
| 70 | 317 |
| 71 | 304.3 |
| 72 | 291.6 |
| 73 | 278.9 |
| 74 | 266.2 |
| 75 | 253.5 |
| 76 | 240.8 |
| 77 | 228.1 |
| 78 | 215.4 |
| 79 | 202.7 |
| 80 | 190 |

## تقييم الجرعة الاشعاعية الفعالة وخطر الاصابة بالسرطان عند المرضى الكبار من فحوصات التصوير الطبقي للبطن والحوض في الضفة الغربية

**إعداد : ولاء حجازي سليمان انعيم**

**المشرف : د. حسين المصري**

## الملخص :

تعتبر الماسحات الطبقية المصدر الأكبر للأشعة التي يتعرض لها المرضى خلال تشخيص امراضهم. هناك حوال 24 جهاز تصوير طبقي في الضفة الغربية. في حالات مثل التصوير الطبقي مثاليا تعطي جرعة ممتصة 10 مليسيفرت تقريبا حيث تعتبر هذه القيمة الطبيعية عالميا هذه الجرعة تعادل ما يقارب 400 صورة اشعاعية (خلفية – امامية ) للصدر. لذلك هناك حاجة لفحص وتقييم الجرعة الممتصة وتقييم خطر الاصابة بمرض السرطان مدى الحياة باستخدام تقرير الآثار الحيوية للاشعاع المؤين, خلال كل المسوحات الطبقية في فلسطين للتوصية بعمل بروتوكول او آلية للتحكم في جرعة المسح الطبقي وبالتالي ضمان حماية المريض.

الأشعة الاضافية تعني خطر أكبر للسرطان او الآثار الصحية العكسية الأخرى والتي ربما تعزى الى هذه الأشعة الاضافية من الفحوصات الطبقية. الهدف الرئيسي من هذه الدراسة هو تقييم جرعة الاشعة الممتصة المعطاة خلال التصوير الطبقي وخطر السرطان مدى الحياة للمرضى الكبار (18–80 سنة) والذين تم عمل فحوصات طبقية للبطن والحوض لهم في 6 مستشفيات رئيسية حكومية وخاصة في الضفة الغربية. تم جمع بيانات الدراسة من خلال تقارير شاشة جهاز التصوير الطبقي الموثقة خلال شهرين في المستشفيات المختارة.

كان معدل الجرعة الممتصة 11.8 ± 5.3 ميليسيفرت للعدد الكلي للراسة تراوح بين 0.5 الى 36.97 ميليسفرت, بينما كان معدل خطر حدوث حالات جديدة للسرطان بين العدد الكلي للسكان يتراوح بين القليل جدا الى المتوسط, حيث كان المعدل 0.082% (1 من كل 2116), بينما كان معدل خطر الوفاة من السرطان مدى الحياة 0.049%(1 من كل 3164) , والذي يعتبر بين منخفض.

في القطاعات, كان معدل الجرعة الممتصة 11.45 ± 6.4 ميليسيفرت للقطاع الخاص تراوح بين 1.77 الى 36.79 ميليسفرت, بينما كان معدل الجرعة الممتصة 12.16 ± 4.1 ميليسيفرت للقطاع الحكومي تراوح بين 0.5 الى 25.2. بالنسبة للمستشفيات, اعلى معدل جرعة ممتصة كانت في مستشفى الرازي مع الممتصة 16.41 ± 7.2 ميليسيفرت, واقل قيمة لها كانت في المستشفى الاهلي بمعدل 7.93 ± 3.7 ميليسيفرت.

بينما اعلى معدل خطر حدوث حالات جديدة كان في مستشفى الرازي بمعدل 0.122% (1 من كل 1187) والأقل كانت في المستشفى الأهل يبمعدل 0.050% (1 من كل 2602), اعلى معدل خطر خطر الوفاة من السرطان كان في مستشفى الرازي بمعدل 0.071% (1 من كل 1856) والأقل كانت في المستشفى الأهلي بمعدل 0.031% (1 من كل 4061).

معدل الجرعة الممتصة للمرضى الكبار ممن تم عمل فحوصات طبقية للبطن والحوض لهم في هذا العمل كان ضمن المستوى المقبول. معدل خطر حدوث حالات جديدة وخطر الوفاة من السرطان مدى الحياة كانت جميعها منخفضة.