7-30-2021

X RADIATION DOSE MONITORING FOR ADOLESCENT AND ADULT PATIENTS IN SELECTED HEALTH CARE ENVIRONMENT RELATED PLACES

Kevin Riandi

Department of Physics, Faculty of Mathematics and Natural Sciences, University of Udayana, Bali, Indonesia, riandinababanbekantan@gmail.com

Follow this and additional works at: <https://scholarhub.ui.ac.id/jessd>

Part of the [Biophysics Commons](#), and the [Nuclear Commons](#)

Recommended Citation

Riandi, Kevin (2021). X RADIATION DOSE MONITORING FOR ADOLESCENT AND ADULT PATIENTS IN SELECTED HEALTH CARE ENVIRONMENT RELATED PLACES. *Journal of Environmental Science and Sustainable Development*, 4(1), 51-68.

Available at: <https://doi.org/10.7454/jessd.v4i1.1066>

This Original Research Article is brought to you for free and open access by the School of Environmental Science at UI Scholars Hub. It has been accepted for inclusion in Journal of Environmental Science and Sustainable Development by an authorized editor of UI Scholars Hub.

X RADIATION DOSE MONITORING FOR ADOLESCENT AND ADULT PATIENTS IN SELECTED HEALTH CARE ENVIRONMENT RELATED PLACES

Kevin Riandi^{1*}

¹Department of Physics, Faculty of Mathematics and Natural Sciences, University of Udayana, Bali, Indonesia

*Corresponding author: riandinababanbekantan@gmail.com

(Received: 12 September 2020; Accepted: 29 July 2021; Published: 30 July 2021)

Abstract

A study on patient absorption dose according to age group was carried out. The amount of absorbed dose of X-ray radiation affect the body cells. Health care hospitals such as clinics, environments that use ionizing radiation. Based on the procedure for using ionizing radiation for medical purposes, the Indonesian Nuclear Energy Supervisory Agency recommends monitoring radiation doses for health workers on health service environment. Likewise with the patient, because the patient is directly exposed to the ionizing radiation. Some research explained that the probability of the greatest stochastic effect on interventional cardiology procedures with X-rays of young patients whose radiation dose has been measured is the occurrence of leukemia, in other research found on baby and toddler patient that there was a significant difference in the absorbed dose in each patient's age group. This study aims to determine the comparison of the absorbed X-ray doses on thorax examination received by patients in the three youngest and oldest age groups. The data that support the calculation of the absorbed dose first find the exposure dose calculation by set value on the control panel of the X-ray machine to each patient is checked are the voltage, current, focal length of the patient's X-ray field, and the age of the patient. Determination of the absorbed dose was carried out using an equation, namely the milliroentgen unit. The exposure dose, milliRoentgen, was converted to an absorbable dose unit, mGy. Average absorption dose per age was compared by one-way ANOVA statistical analysis. The results showed that the absorbed dose of X-rays of patients at the Quantum Diagnostic Clinic for each age group had an insignificant comparison value. The absorbed dose in late adolescence and early adulthood did not have a significant difference. Dosage between early adolescence and late adulthood also did not have a significant difference. Thus, at the Denpasar Quantum Clinic, the absorbed dose of radiation received on young patients is relatively safe compared to the older age group. There was no significant difference in the value of the absorbed dose between one age group and another.

Keywords: X-rays; Absorbed Dose; Radiation; Age Group.

1. Introduction

Radiation is the emission and propagation of energy through matter or space in the form of electromagnetic waves or particles. Radiation is classified into two types, namely ionizing radiation and non-ionizing radiation. When interacting with matter, ionizing radiation can cause ionization,

while non-ionizing radiation does not cause ionization (Sari, Sutapa, & Gunawan, 2020). The use of X-rays in the health sector is one way to improve public health (Ratnawati, Suandayani, & Sutapa, 2019). When the electrons hit the target, X-rays that occur over two processes at the atomic level, Characteristic Radiation and Auger Effect (Podgoršak, 2016). X-rays can be produced by shooting their way at a metal target with fast electrons in X-ray tube cathode. When the electrons reach the target, most of the electron energy is transformed in the form of heat, and some of the energy is transformed to produce X-rays (Miniati, Sutapa, & Sudarsana, 2017). The interaction of photons with particles consists of three ways, the Photoelectric Effect, the Compton Effect and Rayleigh Scattering (Leroy & Rancoita, 2016). In the early decades of using W.H Roentgen's X-rays, the effects of radiation on burnt skin were reported, and cases of cancer were found within seven years after exposure to high-dose X-ray radiation (Muqmiroh et al., 2018). Radiobiological investigations started immediately after the discovery of X-rays, the qualitative approach dominated until the end of World War II. After 1945, the nuclear weapons race and nuclear energy programs initiated quantitative radiobiological research. Radiation protection biology does not provide results from which radiation risks can be directly derived (Wojcika & Harms-Ringdahl, 2019). The safety factor is important to minimize the risks and impacts that arise from using X-ray radiation. The application of radiation safety management aspects is an action to protect patients, workers, and community members from radiation hazards (Hadinata & Rupiasih, 2020).

The medical imaging system is becoming increasingly important in line with policy, with more emphasis on preventive and promotive efforts rather than curative health efforts. The goal is to protect and improve healthy people to be healthier and more productive and to be able to detect disease as early as possible (Kartawijaya, 2002). A fairly reliable and sensitive diagnostic technique for soft tissue is ultrasound imaging (Ulum et al., 2013). Ultrasonography (USG) is a non-invasive diagnostic technique that provides a detailed structural description (Noviana, Widyananta, Parnayoga, & Zaenab, 2013). New medical devices such as the X-ray machines, tomography, magnetic resonance imaging, radiation scans, etc. are present to support professional works of clinicians (Ngan et al., 2016). The on-going development of imaging technology helped to solve many challenges in medical imaging today (Ali, Son, Khan, & Tung, 2017). X-ray radiography has experienced a development towards digital X-ray radiography where the imaging technique uses digital sensors to capture images (Louk & Suparta, 2016). X-rays and gamma rays are ionizing waves. X-rays has to be catch and process into image information to create an image from an attenuated X-ray beam (Suetens, 2009). The thorax is a conical cavity that extends from the neck to

the diaphragm, with the size of the bottom being larger than the top and the back being longer than the front (Hadinata & Rupiasih, 2020).

The X-ray examination technique is carried out in several kinds of projections, Postero-Anterior projection is performed where the X-ray source is directed from behind the patient. Lateral projection is performed where the X-ray source is directed from the left or right side of the patient (Miniati, Sutapa, & Sudarsana, 2017). Several studies have shown the relationship between X-ray examinations performed in various projections with the patient's absorbed dose showing that the patient's dose in the three chest projections exceeds the dose recommended by the IAEA and the European Commission reference dose levels (Rasuli et al., 2016). Another function of the chest X-ray examination is as a standard general examination to see the overall condition of the body, assist in diagnosis, and assist in the evaluation process. Studies show that children under the age of ten are more sensitive to ionizing radiation than adults (Widiyati, 2013). The interaction of radiation with the human body will cause health effects. These health effects, which begin with events that occur at the molecular level, develop into clinical symptoms (Hiswara, 2015). Radiation can cause immediate effects but also long-term effects that can occur years or generations later. The biological effects of radiation result from the direct and indirect action of radiation. There are two types of biological effects, deterministic and stochastic (Choudhary, 2018).

The amount of X-ray radiation used will affect cells. Anatomical and physiological differences between children and adults make them more sensitive to radiation (Muqmiroh et al., 2018). In general, children have a longer life expectancy, increase the risk of long-term radiation effects than adults (Widiyati, 2013). In hospital environment, has radiology room, base on statement above, it's important to measure radiation dose on hospital because person at young age might be at hospital at some moment. Every radiology installation must pay attention to radiation protection on hospital environment, especially protection for radiology rooms. This radiation needs to be protected to reduce the possibility of bad effect that may not occur (Ancila & Hidayanto, 2016). The problem of radiation exposure in the natural environment affects human life that is exposed to ionizing radiation from the natural environment. The environments that often use ionizing radiation are hospitals and clinics. Health care worker exposure to ionizing radiation is important to put attention because of the health risks involved. Health care workers in charge of radiology who are exposed to this type of radiation need to be monitored every day (Garcia-Sanchez et al., 2018).

The reason is, in a hospital environment, health workers need to measure their radiation exposure, as well as their patients. The patient also needs to be measured the exposure dose and the absorption dose of ionizing radiation, because the patient is directly exposed to ionizing radiation.

Radiation doses also referred to as absorbed radiation dose, is the amount of energy deposited in a given mass of a medium by ionizing radiation (L'Annunziata, 2012). In the past, various quantities have been used for specification of the dose in diagnostic radiology and there has been ambiguity because the same name has been used for different quantities (Pernicka & McLean, 2007). Regarding the effect of radiation on the hospital environment, research conducted by Lailatul Muqmiroh in 2018, explained that the greatest possibility of a stochastic effect on interventional cardiology with X-rays of young patients whose radiation doses were measured was the occurrence of leukemia.

The potential for DNA damage in the hospital environment due to radiation at the age below and above 45 years was carried out by Darlina's research in 2018, showing that there was no relationship between the parameters under investigation as an indication of DNA damage with the type of work, age, and gender. Reginald Maleachi, in 2018 revealed the conclusion of his research that radiation investigations in medical practice need to be accurate. The radiation dose should be in the more recommended dose (Maleachi & Tjakraatmadja, 2018). Then, the purpose of this research to determine the comparison of the absorbed dose of patients base the age group of late teens, early adults and late adults. Threshold dose can be defined as a dose under which there is no specific tissue reaction (Sminia et al., 2020). On this case, the 'threshold dose' is defined as the estimated dose required to cause a specific, observable effect in the exposed individual. The estimated recommended threshold dose on PA and LAT chest examinations is 0.14 mGy. Although it is not a 'correct' threshold, it is of practical value to be used as a guideline in radiation protection, it does not mean that no biologic effects occur at lower doses (Oakley, Cuttler, & Harrison, 2018). In this study, to determine the patient's absorbed dose, it is first necessary to determine the exposure dose from the control panel of the X-ray machine. The relationship between the voltage used and the absorbed dose obtained is that if the voltage (kV) used is greater, the absorption dose produced will also be greater but also depends on several factors, consists of current (mA), distance (cm) and time (s) (Mulyono & Subagiada, 2020).

It is important to know the dose of X-ray radiation the patient receives. The younger the patient is, the absorption dose of X-ray radiation should not get dose that one day will harm the patient in the living cells in their body.

2. Methods

In this study, the dosage comparison of patients at the Quantum Diagnostic Clinic was carried out. Comparisons were made using the Oneway Anova statistical analysis method between adolescence,

early adulthood, and late adulthood. The study starts August until October 2019. Comparing the dosage by look at the significant difference with the patient's age group because younger ages are more susceptible to radiation, in this case X-ray radiation. In the end, it is very important to determine the dose in each patient group.

The equipment used was an X-ray machine with the brand "MIS", namely a control panel to regulate the radiation of the X-ray machine. Data are processed by write on a table consisting of the number, patient age (years), X-ray field voltage (kV), X-ray current machine (mAs), patient exposure dose (mR), and patient absorption dose (mGy).

Patients were categorized based on age according to the age categorization of patients from the Ministry of Health of the Republic of Indonesia, namely late adolescence (seventeen to twenty five years), early adulthood (twenty-six to thirty-five years), late adulthood (thirty-six to forty-five years). X-rays and other supporting devices for X-ray radiation are prepared. At first set the focus distance to the film at a distance of 150 cm. Adjust the patient's position for thoracic examination according to the examination procedure. Exposing and inspections are held from the X-ray machine operating room through the control. The results of voltage (kV), current (mAs), time (t) and distance (cm), as well as the patient's age, are recorded every examination were held. The number of patient data obtained was one hundred and twenty one people. Consist of late adolescence, seventy-seven data, early adult thirty-four data, late adult ten data. The results obtained from the calculation in units of milliRoentgen (mR) based on the equation below (Ayad et al., 2002):

$$X \text{ (mR)} = \frac{P.(kV)^2.mAs}{R^2} \quad (1)$$

Then the milliRoentgen (mR) unit is converted into the absorption dose unit, namely milliGray (mGy). For each age where there is more than one respondent, the average value of the respondent's data at that age is taken. Each dose value in the late adolescent, early adulthood, and late adult groups had an absorption dose ratio.

The statistical analysis applied to the data was one-way analysis of variance (ANOVA). Analysis of Variance (ANOVA) is used to determine whether the mean of three or more value distributions (groups) is significantly different from one another (Anas, 2019). It is called one-way analysis of variant because the analysis uses variance and the observed data is the influence of one factor. The purpose of the one-way ANOVA test is to compare by signification on more than two averages (Setiawan, 2019). With a significance of 0,05. The hypothesis tested are, H^0 , there was no difference in the X-ray absorption dose for each age group, and H^1 , there was a difference in the X-ray absorption dose for each age group.

3. Results and Discussions

Comparison of the dose absorbed by patients was carried out by classifying three types of age, namely late adolescence, early adulthood and late adult. Late adolescence ranges in age from seventeen to twenty-five years, early adulthood ranges from twenty-six to thirty-five years and late adulthood ranges from thirty-six to forty-five years.

3.1. X-ray absorption dose data for each patient age group

3.1.1. Characteristics of X-ray absorption dose data for each patient age group

The data obtained on the group of late adolescents are quite diverse. Characteristics of absorbed dose data explained after get process by method above. The average exposure dose and absorbed dose of patients in the late adolescent age group can be shown in Table 1. Table 1 consists of data late adolescence such as age group of 17 years were eight, the data obtained in the age group of 18 years were four, the data obtained in the age group of 19 years were four, the data obtained in the age group of 20 years were eight, the data obtained in the age group of 21 years were five, the data obtained in the age group of 22 years were seven, the data obtained in the age group of 23 years were twelve, the data obtained in the age group of 24 years were sixteen, the data obtained in the age group of 25 years were five. The youngest age, namely seventeen years, obtained the highest absorption dose value in the late adolescent group. Then it dropped dramatically at the age of eighteen. After the age of eighteen, the more the patient gets older, the absorbent dose of the patient also increases. But at the age of twenty-two, the absorbed dose decreases. The X-ray absorption dose value rose again at the age of twenty-three and the absorption dose value decreased with age. The age that got the highest dose in the late adolescent group was seventeen years old and the lowest was nineteen years old.

Table 1. Data on Average Absorbed Dose and Exposure of Late Adolescence (17-25 years)

No.	Patient Age (years)	Average Patient Exposure Dose (mR)	Average Patient Absorbed Dose (mGy)
1	17	10.58	0.0916
2	18	10.687	0.092
3	19	9.505	0.0817
4	20	10.686	0.0923

No.	Patient Age (years)	Average Patient Exposure Dose (mR)	Average Patient Absorbed Dose (mGy)
5	21	12.24	0.1062
6	22	10.678	0.0924
7	23	12.245	0.1055
8	24	11.605	0.0998
9	25	10.589	0.0916

The data obtained from the group of early adulthood is quite diverse. The average exposure dose and absorbed dose of patients in the early adulthood age group can be shown in Table 2. Table 2 consists of data early adulthood such as age group of 26 years were three, the data obtained on the age group of 27 years were six, the data obtained in the age group of 28 years were three, the data obtained in the age group of 29 years were three, the data obtained in the age group of 30 years were three, the data obtained in the age group of 31 years were one, the data obtained in the age group of 32 years were five, the data obtained in the age group of 33 years were three, the data obtained in the age group of 34 years were two, the data obtained in the age group of 35 years were five. The youngest age obtained a dose value that was close to the mean absorption dose of the initial adult patient. Then it decreases with age until the age of twenty-eight. The age of twenty-nine went up and the age of thirty went down again. The age of thirty-one rises again to the age of thirty-two. The age of thirty-three declines and rises again at the age of thirty-four. The oldest age in the group of early adulthood, the absorbed dose has a decreased value. The age with the highest absorption dose value was thirty-two years, and the age with the lowest score was twenty-eight years.

Table 2. Data on Average Absorbed Dose and Exposure of Early Adulthood (26-35 years)

No.	Patient Age (years)	Average Patient Exposure Dose (mR)	Average Patient Absorbed Dose (mGy)
1	26	11.91	0.10311
2	27	11.18272	0.09717
3	28	10.24484	0.08902

No.	Patient Age (years)	Average Patient Exposure Dose (mR)	Average Patient Absorbed Dose (mGy)
4	29	12.0608	0.10442
5	30	11.16097	0.09698
6	31	12.4416	0.10811
7	32	14.06193	0.1219
8	33	11.086	0.0959
9	34	12.0986	0.1051
10	35	11.1779	0.0968

The data obtained from the group of late adulthood is quite diverse. The average exposure dose and absorbed dose of patients in the late adulthood age group can be shown in Table 3. Table 3 consists of data late adulthood such as age group of 37 years were one, the data obtained in the age group of 38 years were two, the data obtained in the age group of 40 years were two, the data obtained in the age group of 41 years were one, the data obtained in the age group of 43 years were one, the data obtained in the age group of 45 years were three. The youngest got the highest dose value of all ages. Then the age of thirty-seven years got the absorption dose value that decreased from before, then the absorption dose value decreased again at the age of thirty-nine years. The dose value rises again with age, up to forty-two years. Then the absorption dose value decreases until the oldest age is forty-five years. The youngest age got the highest dose value and the age who got the lowest dose value was thirty-nine years.

Table 3. Data Classification of Late Adulthood (36-45 years)

No.	Patient Age (years)	Patient Exposure Dose (mR)	Patient Absorbed Dose (mGy)
1	43	11.9	0.103
2	45	9.55	0.082
3	37	31.6	0.27
4	45	12.21	0.105
5	38	11.9	0.103
6	41	11.76	0.1

No.	Patient Age (years)	Patient Exposure Dose (mR)	Patient Absorbed Dose (mGy)
7	40	11.98	0.1
8	45	11.76	0.1
9	40	9.19	0.079
10	38	15.84	0.13

3.1.2. X-ray absorption dose values for each patient's age group

The mean value of the late adolescent patient absorption dose in the figure shows that the youngest age, seventeen years, is the largest relative absorption dose. The graph in the Figure 1, shows that the absorbed dose for the younger age group is higher. From the graph Figure 1, it can also be seen that with increasing age the value of absorbed dose decreases and then varies, sometimes up and down. The value obtained for the age of seventeen was 0.23 mGy, which is greater than that of the ages of eighteen to twenty-five. The second largest absorption dose was twenty-one years of age, touching 0.106 mGy. Eighteen years got 0.09 mGy, nineteen years got 0.08 mGy, twenty years got 0.09 mGy, twenty-two got 0.09 mGy, twenty and three got 0.1 mGy, age twenty-four gets 0.09 mGy, and age twenty-five 25 gets 0.09 mGy. The average absorption dose received by the late adolescent group was 0.1 mGy.

Figure 1. Graph of late adolescent patient age with X-ray absorption (mGy)

Early adulthood indicates that the youngest does not score relatively high. The graph in the Figure 2, shows that the absorption dose for the 32-year-old group is higher. From the graph Figure 2, it can also be seen that with increasing age the value of the absorbed dose also varies, sometimes up and down. However, the highest score was at age thirty-two, with 0.12 mGy. Then followed by the age of thirty-four years 0.1 mGy. Twenty-six years old got 0.1 mGy, age twenty-seven got 0.09

mGy, age twenty-eight got 0.08 mGy, age twenty-nine got 0.104424942 mGy, age thirty got 0.09 mGy, age thirty-one got 0.1 mGy, age thirty-three got 0.09 mGy, age thirty-five got 0.09 mGy. The average absorption dose received by the early adulthood group was 0.1 mGy.

Figure 2. Graph of early adult patient age on X-ray absorption (mGy)

Increasing age has a relatively low developmental graph compared to the youngest age, late adolescence. The graph in the Figure 3, shows that the absorption dose for the 37-year-old group is higher. From the graph Figure 3, it can also be seen that with increasing age the value of the absorbed dose also varies, sometimes up and down. But it does not approach and exceed the age bracket of late adolescence, that is, age thirty-seven with an absorbed dose of 0.27 mGy. Thirty-eight years of age get 0.12 mGy, age forty 0.09 mGy, age forty-one gets 0.1 mGy, age forty-three gets 0.1 mGy, age forty-five gets 0.09 mGy. The average absorption dose received by the elderly adult group was 0.1 mGy.

Figure 3. Graph of the age of the final adult patient using X-ray absorption (mGy)

3.2. Determining the absorption dose value of each age group and comparison results

Knowing the patient's absorption dose can be done by knowing the dose of exposure to X-rays in advance. The component for determining the exposure dose is the effect of tube current (mA). The tube current comes from heating the filament, if the heating of the filament is increased then the

current in the X-ray tube also increases. All X-ray intensities or degrees of light (brightness) will increase according to the increase in the X-ray radiation intensity at the focal point. The tube currents determine the number of electrons that will pass through the target (anode). Then, X rays are produced that have sufficient intensity and energy to penetrate certain organs. Effect of voltage (kV).

The tube voltage affects the quality of the radiation or the penetrability of the X-rays produced. Thus it will also affect the formation of the picture because the change in kV will cause a total change in the intensity of the X-ray beam. Then the effect of distance (cm). In the X-ray shooting process, there is a distance setting known as FFD (Focus Film Distance) which is the focal distance of the X-ray tube to the surface of the film; The smaller the FFD value, the film density will increase due to the increased X-ray intensity. The distance setting can be done by moving the tube stand away from or near the object, affect the intensity of the X-ray beam which in turn will also affect the formation of radiographic images (Musfira, 2016). The equations used to determine the dose of exposure are (Ayad et al., 2002):

$$X \text{ (mR)} = \frac{P \cdot (kV)^2 \cdot mAs}{R^2} \quad (2)$$

Where X is the dose of exposure, has milliroentgen units (mR), P is 15, tube voltage has units of kiloVolts (kV), then squared, tube current strength has milliamperere units, then multiplied by time units, namely seconds, then it becomes milliAmpere second (mAs)). The distance from the tube to the patient in centimeters (cm) is represented by the symbol "R", then the distance is squared.

The absorption dose value that has been obtained in milliroentgen (mR) units, is converted to milliGrays (mGy) absorption dose units. The exposure dose in mR is converted into the absorbent dose unit of mGy by comparison, where 1 mR is equal to 87.7 mGy (Hendra Hadinata I Made, 2020). Distribution of each patient by age category. Age is the life span measured in years, it is said that the end is the age range of 17-25 years, adulthood is the age range of 26-35 years, late adulthood is the age range of 36-45 years. Age is life in years calculated from birth. Age is a person's age which is calculated from birth to his birthday. As shown in the following Table 4. (Adi, 2015).

Table 4. Patient Age Category

No.	Age Group	Age
1.	Toddler Mass	0 – 5
2.	Childhood Mass	5 – 11
3.	Early Teenage Mass	12 – 16
4.	Late Teenage Mass	17 – 25
5.	Early Adult Mass	26 – 35
6.	Late Adult Mass	36 – 45
7.	Early Elderly Mass	46 – 55
8.	Late Elderly Mass	56 – 65
9.	Old Age	65 – top

(Source: [Adi, 2015](#))

Comparison of absorbed dose for each age was carried out to determine differences in X-ray absorption doses obtained in late adolescence, early adulthood and late adulthood at Quantum Sarana Medik Clinic, Denpasar. Knowing the ratio of the X-ray absorption dose to the age group needs to be done because the youngest patient age group has the longest life expectancy. The value of the absorbed dose obtained is expected not to exceed the age of the older patient and endanger the patient. So, the need for X-rays for medical health examinations and diagnosis of patients' diseases can be achieved without harming the patient's body. So, it is important to know the X-ray absorption dose for that age group.

Looking for literature studies related to electromagnetic waves, X-ray irradiation, the dangers of X-rays to humans, getting the dose of X-ray exposure to humans and the absorption dose of X-rays for humans, was carried out support the results of this study. Data retrieval is adjusted to the literature study conducted. The data used to support obtaining X-ray absorption doses are exposure dose and exposure dose equation with absorption dose. Getting the absorption dose required data on the X-ray machine tube current, the X-ray machine tube current voltage and the X-ray machine tube distance to the patient. Knowing the comparison, it is necessary to have the patient age classification literature, the patient's age data. Finally, comparisons were carried out with a one-way

ANOVA statistical analysis of the absorption dose for late adolescent, early adult and late adult patients.

3.3. Comparison of X-ray absorption doses for each age group

Each age group is looked for the average of each age. The mean age is seventeen to the mean age of twenty-five of the late adolescent group. The mean age is twenty-six to the mean age of thirty-five of the early adulthood group. The mean age was thirty-six to the mean age of forty-five of the final adulthood group.

Comparison of absorption dose values by age group, with a significance of 0.05. The hypothesis that was applied was, H_0 , there was no difference in the absorption dose of X-rays for each age group, and H_1 , there was a difference in the X-ray absorption dose for each age group. Comparison of late adolescence with early adulthood through one-way analysis of variance (ANOVA) with a P-value of 0.5, which means that hypothetical H_0 is accepted. So, there is no significant difference in the X-ray absorption dose of late adolescence. and early adulthood. Comparison of early adulthood and late adulthood through a one-way analysis of variance (ANOVA) with a P-value of 0.2 which means that hypothetical H_0 is accepted. So, there is no significant difference in the absorption dose of X-rays in early adulthood. Comparison of late adulthood and late adolescence through one-way analysis of variance (ANOVA) with a P-value of 0.5, which means that hypothetical H_0 is accepted. So, there is no significant difference in the absorption dose on late adult and late adolescence. Comparison of all age groups from late adolescence, early adulthood and late adulthood through one-way analysis of variance (ANOVA) with a P-value of 0.4, which means that hypothetical H_0 is accepted. So, there is no significant difference in the dose of light absorption X-ray in all ages of late adolescence, early adulthood and late adulthood at the Quantum Diagnostic Clinic from August to October.

The statistical approach used in analyzing the patient's absorbed dose data in each age group obtained results, accepted the initial hypothesis or H_0 , which means that there is no significant difference in the X-ray absorbed dose. In general, the surface of the skin on X-ray examination of the chest or thorax is the most extensive of any examination of other body parts. Examination of the chest or thorax has the most extensive skin surface applicable to all age groups, in this case the absorbed dose obtained in the late adolescence, early adult, and late adult age group, obtained a dose value below the standard absorbed dose threshold on the skin surface, which has been determined by the Nederlandse Commissie Voor Starlings Dosimetry in 2016. Although the early teens received an absorption dose that was not much different from early adulthood and late

adulthood with the acceptance of hypothesis H_0 , in this study the absorbed dose of the youngest age group, namely late adolescence, did not have different absorbed dose values with older age groups, namely early and late adulthood.

Likewise, early adulthood, which is a younger age group than the late adult age group, did not get a different absorbed dose value from the late adult age group. In the clinical environment, for younger patients, even though they have anatomical and physiological differences between younger and older ages, make young people more sensitive to radiation, and young people have a longer life expectancy, making long-term risks also greater, the absorption dose obtained at a young age is relatively safe compared to the absorption dose of radiation in the older age group. Although the absorbed dose received by younger patients did not have a different value with older patients in this study, the absorbed dose received by each age group of patients was still below the X-ray threshold dose on the skin surface set by the Nederlandse Commissie Voor. Starlings Dosimetry in 2016.

4. Conclusion

Each age group also shows a declining graph. It also shows that the youngest age in each age group has the highest absorption dose value. The smallest absorption dose is the early adult age group with a value of 0.101875223236667 mGy, then the late adolescent group is 0.111644909014332 mGy, and the largest absorption dose value is the late adult group with a value of 0.130658033138889 mGy.

Statistical analysis of variance (ANOVA) test conducted on late adolescents and early adulthood did not show any differences. Early adulthood and late adulthood showed no difference. There is no significant difference to late adolescence and early adulthood. Thus, the ratio of X-ray uptake dose at the Quantum Diagnostic Clinic from August to October 2019 in each age group, late adolescence, early adulthood, and late adulthood was no significant difference. This means that in the youngest age group, late adolescents do not get the absorption dose value that far exceeds the dose in the older age group, namely early adulthood and late adulthood. The early adult group also did not get absorption dose values that far exceeded or exceed the absorption dose values for the final adult group. In the health center environment, in this case the Quantum Clinic, Denpasar, the absorption dose of X-ray radiation for the young age group does not exceed the older age. So, the absorption dose of radiation in young patients has not significant difference to older patient, despite having anatomical and physiological differences between children and adults makes them more sensitive to radiation, and younger patient age have a longer life expectancy, making them the long-term risk of the radiation absorb dose is also greater. Although there was no significant difference, the absorbed

dose value obtained by each age group was still below the standard dose threshold recommended by the Oakley, Cuttler and Harrison in 2018. Based on this statement, it can be concluded that the absorbed dose of patients in the late teens, adults Early and late adulthood in the Quantum Diagnostic Clinic environment from August to October 2019 were classified as safe. Based on Lailatul Muqmiroh's statement in 2018 and Widayati in 2013 regarding X-ray radiation will affect body cells, which in children or younger age patient, they have a longer life expectancy. So, the long-term effects of radiation are also greater than those of older age. Not to forget also the anatomical and physiological differences between children and adults make them more sensitive to radiation. So, based on statements before, the absorbed dose of X-ray radiation obtained based on the age range in the Quantum Diagnostic Clinic environment from August to October 2019 on this research was considered safe.

The age ranges worked on in this study were late adolescence, early adulthood and late adulthood. The youngest age in this study was the late adolescent age group. Anatomically, the late adolescent group has experienced puberty which is the same body shape until it grows up. The value of the absorbed dose should not exceed a predetermined threshold dose. Patients with young age, have a longer life expectancy. So, the long-term effects of X-ray radiation on younger patients will be more impactful than older patients. It is recommended that developments in similar research with this study further develop the categorization of younger patient ages and measurement of absorbed dose using radiation other than X-rays, such as gamma (γ) rays.

Acknowledgment

Thank you to the Quantum Sarana Medik Main Clinic for providing permission and facilities in conducting research and to the lecturers at the Physics Study Program, FMIPA, Udayana University for the guidance that has been given to make this publication a reality.

Author Contribution

Kevin Riandi looks for problems that can be studied from the Quantum Diagnostic Clinic, especially in the radiology department. Looking for a suitable reference to solve the problem and process it and helps translate sentences to better fit the context. Also, using a statistical approach in processing data.

References

- Adi, S. (2015). Hubungan Indeks Massa Tubuh (IMT) dan Umur Terhadap Daya Tahan Umum (Kardiovaskuler) Mahasiswa Putra Semester II Kelas A Fakultas Pendidikan Olahraga Dan Kesehatan IKIP PGRI Bali Tahun 2014. *Jurnal Pendidikan Kesehatan Rekreasi*. <https://ojs.ikipgribali.ac.id/index.php/jpkr/article/view/6>
- Ali, M., Son, L. H., Khan, M., & Tung, N. T. (2017). Segmentation of dental X-ray images in medical imaging using neutrosophic orthogonal matrices. *Expert Systems With Applications*, 91, 434-441. <https://doi.org/10.1016/j.eswa.2017.09.027>
- Anas, M. (2019). PENGARUH POLA ASUH ORANG TUA TERHADAP PRESTASI BELAJAR BIOLOGI PESERTA DIDIK KELAS VIII MTsN 2 MAROS. *Binomial*, 2(1), 12-32. <http://ejournals.umma.ac.id/index.php/binomial/article/view/183>
- Ancila, C., & Hidayanto, E. (2016). Analisis Dosis Paparan Radiasi Pada Instalasi Radiologi Dental Panoramik. *Youngster Physics Journal*, 5(4), 441-450. <https://ejournal3.undip.ac.id/index.php/bfd/article/view/14133>
- Ayad, M., Bakazi, A., & Elharby, H. (2002). Dosimetry measurements of X-Ray machine operating at ordinary radiology and fluoroscopic examinations. *Proceedings of the Third Nuclear and Particle Physics Conference (NUPPAC-2001)*, 502. http://inis.iaea.org/search/search.aspx?orig_q=RN:37110249
- Choudhary, S. (2018). Deterministic and Stochastic Effects of Radiation. *Cancer Therapy & Oncology International Journal*, 12(2). <https://doi.org/10.19080/CTOIJ.2018.12.555834>
- Garcia-Sanchez, A.-J., Garcia Angosto, E., Moreno Riquelme, P., Serna Berna, A., & Ramos-Amores, D. (2018). Ionizing Radiation Measurement Solution in a Hospital Environment. *Sensors*, 18(2), 510. <https://doi.org/10.3390/s18020510>
- Hadinata, I. M. H., & Rupiasih, N. N. (2020). Monitoring the Absorption Dose of X-ray Radiation on the Thoracic Examination. *BULETIN FISIKA*, 21(1), 8-13. <https://doi.org/10.24843/BF.2020.v21.i01.p02>
- Hiswara, E. (2015). *Buku Pintar Proteksi dan Keselamatan Radiasi di Rumah Sakit*. BATAN Press. <http://repo-nkm.batan.go.id/id/eprint/2573>
- Kartawijaya, H. (2002). *Segmentasi Dan Rekonstruksi Citra Organ Dalam Tiga Dimensi Menggunakan Matematika Morfologi Dan Riangulasi Delaunay*. Gunadarma.
- L'Annunziata, M. F. (2012). Radiation Physics and Radionuclide Decay. In *Handbook of Radioactivity Analysis* (pp. 1–162). Elsevier. <https://doi.org/10.1016/B978-0-12-384873-4.00001-3>

- Leroy, C., & Rancoita, P. G. (2016). *Principles of radiation interaction in matter and detection*. World Scientific. <https://www.perlego.com/book/852122/principles-of-radiation-interaction-in-matter-and-detection-4th-edition-pdf>
- Louk, A. C., & Suparta, G. B. (2016). Pengukuran Kualitas Sistem Pencitraan Radiografi Digital Sinar-X. *BIMIPA*, 24(2), 149-166. <https://jurnal.ugm.ac.id/bimipa/article/view/13835>
- Maleachi, R. & Tjakraatmadja, R. (2018). Pencegahan Efek Radiasi pada Pencitraan Radiologi. *Cermin Dunia Kedokteran*, 45(7), 537-539. www.cdkjournal.com/index.php/CDK/article/view/647
- Miniati, K., Sutapa, G. N., & Sudarsana, I. W. B. (2017). Uji Kelayakan Pesawat Sinar-X Terhadap Proyeksi PA (POSTERO-ANTERIOR) DAN LAT (LATERAL) PADA Teknik Pemeriksaan Foto Thorax. *Jurnal Buletin Fisika*, 18(1), 27-31. <https://doi.org/10.24843/BF.2017.v18.i01.p05>
- Muliyono, S., & Subagiada, K. (2020). Penentuan Nilai Faktor Mesin Pesawat Sinar-X Radiografi Digital Merek Shimadzu di RSUD Dr. Kanujoso Djatiwibowo Balikpapan. *Progressive Physics Journal* 1(1), 29-39. <http://jurnal.fmipa.unmul.ac.id/index.php/ppj/index>
- Muqmiroh, L., Praptono, S. I., Rusmanto, R., Latifah, R., & Sensusiati, N. D. (2018). The Radiation Dose Profile in Pediatric Interventional Cardiology to Estimate the Stochastic Effect Risk: Preliminary Study. *Journal Of Vocational Health Studies*, 1(3), 107-112. <https://doi.org/10.20473/jvhs.V1.I3.2018.107-112>
- Musfira, A. (2016). *Analisis Perbandingan Dosis Serap Radiasi Foto Thorax pada Pasien dengan Berbagai Tingkatan Umur*. Universitas Islam Negeri Alauddin Makassar. <http://repositori.uin-alauddin.ac.id/3326/>
- Ngan, T. T., Tuan, T. M., Son, L. H., Minh, N. H., & Dey, N. (2016). Decision Making Based on Fuzzy Aggregation Operators for Medical Diagnosis from Dental X-ray images. *Journal of Medical System*, 40(280). <https://doi.org/10.1007/s10916-016-0634-y>
- Noviana, D., Widyananta, B. J., Parnayoga, I. W. W., & Zaenab, S. (2013). STUDI KASUS PENCITRAAN SONOGRAM KELAINAN ORGAN HEPATOBILIARI ANJING (*Canis lupus*). *Jurnal Kedokteran Hewan-Indonesian Journal of Veterinary Sciences*, 7(2). <https://doi.org/10.21157/j.ked.hewan.v7i2.895>
- Oakley, P. A., Cuttler, J. M., & Harrison D. E. (2018). X-ray imaging is essential for contemporary chiropractic and manual therapy spinal rehabilitation: radiography increases benefits and reduces risks. *Dose-Response*, 16(2), 1559325818781437. <https://doi.org/10.1177%2F1559325818781437>

- Podgoršak, E. B., (2016). *Radiation physics for medical physicists* (Vol. 1). Berlin: Springer.
ndl.ethernet.edu.et/bitstream/123456789/44514/1/98.pdf
- Pernicka, F., & McLean, I. D.. (2007). *Dosimetry in Diagnostic Radiology: An International Code of Practice*. International Atomic Energy Agency.
<https://www.iaea.org/publications/7638/dosimetry-in-diagnostic-radiology-an-international-code-of-practice>
- Rasuli, B., Mahmoud-Pashazadeh, A., Ghorbani, M., Juybari, R. T., & Naserpour, M. (2016). *Patient dose measurement in common medical X-ray examinations in Iran*. *Journal of Applied Clinical Medical Physics*, 17(1), 374-386. <https://doi.org/10.1120/jacmp.v17i1.5860>
- Ratnawati, I. G. A. A., Suandayani, N. K. T., & Sutapa, G. N. (2019). *The linearity of x-ray devices radiation output and its relationship with patient thickness*. *International Journal of Physical Sciences and Engineering*, 3(3), 1–6. <https://doi.org/10.29332/ijpse.v3n3.351>
- Sari, N. M. P., Sutapa, G. N., & Gunawan, A. A. N. (2020). *Utilization of Gamma Co-60 Radiation for Chili Plant (Capsicum annum L.) Breeding by Using a Physical Mutagen Method*. *BULETIN FISIKA*, 21(2), 47-52. <https://doi.org/10.24843/BF.2020.v21.i02.p02>
- Setiawan, K. (2019). *BUKU AJAR METODOLOGI PENELITIAN (Anova Satu Arah)*. Universitas Lampung. <http://repository.lppm.unila.ac.id/11352/>
- Sminia, P., Lammertsma, A., Greuter, M., Wiegman, M., De Lange, F., De Fluiter-Zeeman, M., ... , & Van de Kamer, J. B. (2020). *NCS Report 26 Radiation Dose and Risk Estimates: Human Exposure to Ionising Radiation for Clinical and Research Purposes*. *Radiation Dosimetry*. <https://doi.org/10.25030/ncs-026>
- Suetens, P. (2009). *Fundamentals of Medical Imaging*. Cambridge University Press. <https://doi.org/10.1017/CBO9780511596803>
- Ulum, M. F., Paramitha, D., Muttaqin, Z., Utami, N. F., Utami, N. D., Gunanti, ., & Noviana, D. (2013). *Pencitraan Ultrasonografi Organ Reproduksi Domba Jantan Ekor Tipis Indonesiareproduction organ*. *Acta VETERINARIA Indonesiana*, 1(2), 51–56. <https://doi.org/10.29244/avi.1.2.51-56>
- Widiyati, E. (2013). *Analisis Dosis Serap Radiasi Foto Thorax Pada Pasien Anak Di Instalasi Radiologi Rumah Sakit Paru Jember* [Fakultas Matematika dan Ilmu Pengetahuan Alam]. <http://repository.unej.ac.id/handle/123456789/2496>
- Wojcika, A., & Harms-Ringdahl, M., (2019). *Radiation protection biology then and now*. *International Journal Of Radiation Biology*, 95(7), 841–850. <https://doi.org/10.1080/09553002.2019.1589027>