



Patient Dose Monitoring Using Exposure Index Against Body Mass Index Level on Chest X-ray Examination



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Keywords

body mass index;
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Abstract

The image quality factor is not merely a matter of whether the image is repeated or not, but also has a wide range of information and also has to maintain the protection method for the patient is the reception of the dose due to radiographic action. So it is necessary to monitor the patient's dose using the EI value. The factors that determine the EI value are the exposure factor and the thickness of the object or BMI (Body Mass Index). Exposure factors (kV and mAs) are factors that have been commonly used as patient dose monitoring, where the tube voltage is a component that changes more often with a relatively constant tube current. The study used data on patients with Thoracic examination at the age of 20-65 years which were then categorized into BMI. The analysis was carried out on the EI value contained in the radiographic image. The results showed that BMI in the normal, Light Grade Fat (LGF), Heavy Grade Fat (HGF) categories, respectively, the EI values were 1562, 1679, and 1955 for the female sex, and 1266, 1600, and 1821 for the male gender. Significantly ($P \leq 0.05$) the EI value showed difference between female and male sexes.

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1 Introduction

Establishing the diagnosis in some cases can be done by radiological examination. Radiological examination is an examination using X-rays to reveal the object being examined through the manufacture of radiographs that provide as much diagnostic information as possible (Bontrager & Lampignano, 2013). The sophistication of digital imaging technology for diagnostics has been applied in imaging diagnostic services in hospitals. One of them is the use of Computed Radiography (CR). CR is a digital image acquisition and processing system for producing static radiographs. This system uses a standard X-ray tube and a generator but requires a special image receptor and a computerized image processing system consisting of an image receiver, an image reader, and a workstation (Susilo et al., 2012; Sutapa et al., 2018).

The function of digital image processing is to process data that has information suitable for computer processing and to improve image quality (Bushong, 2020). Image quality is a requirement to show the accuracy or representation of the patient's anatomy in the radiograph. An image that can clearly show the structure and soft tissue is said to have a good quality image. While the image is said to have poor quality if it contains images that are difficult to differentiate with the human eye. Optimal image quality with quantitative images helps accuracy in diagnosis, to avoid errors in diagnosis. According to Bontrager & Lampignano (2013), states that the factors used to evaluate the quality of digital images are brightness, contrast, resolution, distortion, noise, and EI. One of the factors that determine the EI value is the exposure factor and the thickness of the object or BMI. So it is necessary to research monitoring patient doses using EI on BMI levels on chest X-ray examinations (Putra et al., 2019; Beydon et al., 1992).

2 Materials and Methods

The research location is in the Radiology Unit of the Kasih Ibu Hospital, Kedonganan, Badung. Meanwhile, data analysis was carried out at the Biophysics Laboratory, Bukit Jimbaran Campus. The tools used in this research are the X-ray device, collimator tool and beam alignment test tool, CR (Computer Radiography), lux meter, humidity meter, thermometer, and X-ray cassette 24 x 24 cm with imaging plate (Silva & Yoshimura, 2014; Costa & Pelegrino, 2014). The object of this research is adult patients with the appropriate provisions of the BMI level. Patients who will undergo the examination are categorized based on the BMI value, patients with a BMI above 27 are categorized as fat, while for skinny patients the BMI value is less than 18. The X-ray tube voltage variable is set from 50,60,70,80 and 90 kVp with 20 mAs. From the measured EI value on the radiographic film for each voltage, the relationship between kVp and the BMI category can be determined, and then the patient dose can be determined according to the BMI level (Jones & Nzekwu, 2006; Frankel et al., 1996). The research data were analyzed comparatively and statistically, by looking at and comparing the observations from the research conducted. The patient's weight data from the medical record adjusted to the BMI level can be determined by the EI value on the radiographic film. Furthermore, it is analyzed to determine the amount of patient dose according to bodyweight category. The statistical analysis used was ANOVA (Analysis of Variance). The ANOVA test results that were significantly different ($P \leq 0.05$) showed a significant difference between the EI and BMI values (Erenstein et al., 2020; Drennan et al., 2019).

3 Results and Discussions

The research data from the examination of thorax patients consisted of 2 categories, namely female and male patients with an age range of 18-65 years as shown in Table 1. following,

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Table 1
Results of examination of thoracic patients against the exposure index

No.	No. Registration	Gender	Weight (kg)	Height (cm)	Age (year)	Exposure		Exposure Type	Exposure Index
						kV	mAs		
1	1776189	M	49	156	30	65	5	Toraks PA	1722
2	1776325	F	58	170	34	62	10	Toraks PA	1143
3	1776334	M	53	163	33	57	5	Toraks PA	1446
4	1778247	F	57	168	32	70	5	Toraks PA	1592
5	1778265	M	68	173	26	63	5	Toraks PA	1339
6	1778340	F	57	158	40	60	6	Toraks PA	1499
7	1778357	M	70	180	34	66	6,3	Toraks PA	1540
8	1778361	F	55	168	31	60	6,5	Toraks PA	1250
9	1781392	M	72	171	59	60	5	Toraks AP	1579
10	1781075	M	69	168	31	66	5	Toraks PA	1450
11	1781567	M	75	170	57	60	4	Toraks AP	1600
12	1782458	M	72	175	28	63	9	Toraks PA	1042
13	1782741	F	60	163	30	55	6,3	Toraks PA	1419
14	1783104	F	76	169	55	66	6,4	Toraks PA	1540
15	1783325	F	80	167	65	73	6,4	Toraks AP	1898
16	1783556	M	62	157	21	60	6	Toraks PA	1402
17	1784356	M	68	155	55	73	10	Toraks PA	1955
18	1784455	F	76	177	61	66	8	Toraks PA	1608
19	1784629	F	67	169	29	60	4	Toraks PA	1175
20	1784599	F	82	170	47	70	10	Toraks PA	1834
21	1785119	F	77	172	38	63	8	Toraks PA	1601
22	1785462	F	68	168	20	63	6,4	Toraks PA	1407
23	1785962	F	67	167	37	63	4	Toraks PA	1254
24	1786141	F	70	170	37	66	12,5	Toraks PA	1534
25	1786028	F	83	172	54	70	6	Toraks AP	1743
26	1786422	M	61	153	60	55	4	Toraks AP	1534
27	1786499	M	50	157	50	60	6,4	Toraks PA	1009
28	1786196	F	69	169	56	66	4	Toraks AP	1388
29	1783225	M	57	160	25	60	6	Toraks PA	1402
30	1784456	M	68	159	55	73	10	Toraks PA	1955

Next, the BMI category is determined for gender and the average value is taken against the EI value, as shown in Table 2. Below

Table 2
The average value of EI against the BMI category

BMI Category Gender	Normal	Light Grade Fat (LGF)	Heavy Grade Fat (HGF)
Female	1821	1600	1266
Man	1955	1671	1562

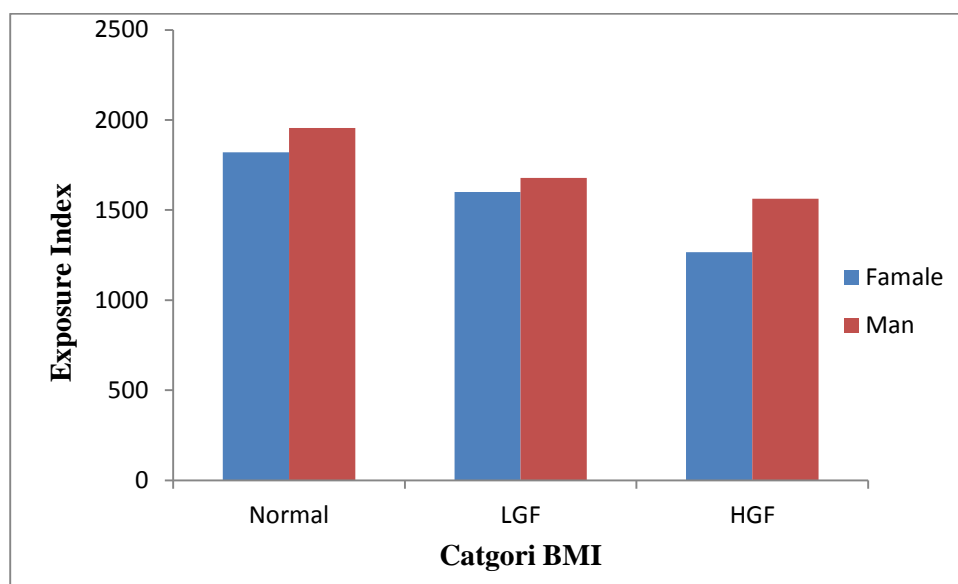


Figure 1. Graph of the relationship between BMI and EI value.

The results of the study as shown in Figure 1, in general, the IE value decreased from the normal BMI, LGF, and HGF categories, for both female and male gender (Adler et al., 1992; Rosidah et al., 2020). It can be understood that EI is a measure of the amount of radiation exposure received by the image receptor (IR). Radiologists and radiographers use the EI standard as the optimal standard of exposure accepted by IR. The EI values listed in the CR have varying ranges. In Carestream/kodak CR, the acceptable IE value is in the range of 1000-2000 (Mothiram et al., 2013). The results of the study have an EI value in the range of 1266 to 1955, which is a value that has met the exposure dose to produce good image quality. Based on the research of Rochmayanti et al. (2019), to get an optimal image on chest examination, an EI value of 1725 is needed. Thus, the LGF and HGF categories still meet the optimal EI value, so the image quality can still be read clearly (Gill et al., 2018; Putra et al., 2021).

Although the EI value is determined by the exposure factor and the thickness of the object or BMI, in this study the EI value was also influenced by gender. Women at all BMI levels had higher EI scores than men. Statistically also showed a significant difference ($P \leq 0.05$) between female and male EI scores (Renehan et al., 2008; Iseki et al., 2004). It can be understood that in general the posture/shape of the female body is anatomically thicker than the male body, so the absorption of radiation doses will occur more in the female patient's body. So the value of EI received by the IR will be smaller. This condition also supports research conducted by Arifiansyah (2018), which states that a person's weight and height will affect the amount of EI value received by the IR (Indonesia, 2009; Strauss & Rae, 2012).

4 Conclusion

The IE value is a measure of the amount of radiation exposure received by the image receptor (IR). The results showed that the IE values for BMI in the normal, LGF, and HGF categories were 1562, 1679, and 1955 for males, and 1266, 1600, and 1821 for females, respectively. Significantly ($P \leq 0.05$) the EI value showed the difference between male and female sexes.

Conflict of interest statement

The authors declared that they have no competing interests.

Statement of authorship

The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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