http://ejournal.seaninstitute.or.id/index.php/healt
Jurnal eduhealth, Volume 13, No 02, 2022
E-ISSN., P-ISSN. 2087-3271

Analysis of Histogram and Grayscale on Chest X-Ray Computed Radiography Image in Covid-19 Disease vs Normal

Hernastiti Sedya Utami[1], Ika Mentari Putri Rahmawati[2], Rifdatul Reski[3]
[1] Department of Radiologic Imaging Technology, Universitas Muhammadiyah Purwokerto, Banyumas,Indonesia
[2] Department of Radiology RSUD dr. Gondo Suwarno, Semarang, Indonesia
[3] Department of Radiology Klinik Pratama Rawat Jalan UMP, Banyumas, Indonesia

ARTICLE INFO

Keywords:
chest x-ray, grayscale, histogram, covid-19.

ABSTRACT

Chest X-ray the main imaging modality for diagnosing Covid-19. An optimal radiograph is needed, so that it can be used as a support for the diagnosis of the disease. The use of digital CR can produce images easily, quickly, optimally, and can be processed as needed. However, it is possible that clinical acquisitions can result in low quality digital images. CR digital images can calculate grayscale and histogram values and can provide clues in diagnosing patients in Covid-19 cases by analyzing that values. Each covid-19 and normal group as many as 18 CXR postero-anterior projection images analyzed by quantitative analysis was conducted by measuring the mean of grayscale values and displayed histogram use ImageJ software. The result is there is a significant difference in the mean grayscale value between normal and covid-19 chest images ($p<0.001$). The grayscale value in the covid-19chest image (117.433±4.314) has a higher grayscale value and histograme range that is more inclined to the right than the normal chest image (65.231±3.304). Finally, histogram and grayscale values are very helpful in establishing the diagnosis of Covid-19.

Email :
hernastitisedyautami@ump.ac.id
Ikamentari94@gmail.com
Rifdatulreski18@gmail.com

1. INTRODUCTION

The thorax is that part of the skeletal system that provides protection for the parts of the chest involved with respiration and blood circulation, defined as the area bounded superiorly by the thoracic inlet and inferiorly by the thoracic outlet, with the outer limit is the thoracic wall composed of thoracic vertebrae, ribs, sternum, muscles, and connective tissue. The thoracic cavity is bounded by the abdominal cavity by the diaphragm. The thoracic cavity can be divided into two main parts: the lungs (left and right) and the mediastinum [1]. There are various indications on the thorax, one of which is covid-19 (Corona Virus Disease 2019). Coronavirus includes viruses that attack the respiratory tract. Viruses associated with respiratory tract infections will use respiratory epithelial and mucosal cells as initial targets and cause respiratory tract infections or organ damage. Covid-19 in humans attacks the respiratory tract, especially the cells that line the alveoli [2].

Beginning in December 2019, the first five cases of pneumonia patients were found in Wuhan City, Hubei Province, China. About 66% of sufferers were exposed at the Huanan seafood market (Wet Market) in the city of Wuhan [3]. Patients with Covid-19 have increased rapidly coming from various countries in Asia, Europe and Australia [4]. On January 30, 2020, WHO sounded the public health emergency alarm which is of concern to the whole world, namely the Public Health Emergency of International Concern (PHEIC) [5]. In Indonesia, the Covid-19 case appeared for the first time in March 2020. Since then, the spread of Covid-19 has expanded until now. Currently the positive number of Covid-19 in Indonesia has reached 4.07 million people with the death toll reaching 132 thousand [6].

Covid-19 has main clinical symptoms that often occur, such as fever, cough, fatigue, myalgia and dyspnea. Someone who has been infected with Covid-19 can transmit the Coronavirus through inhalation or contact with infected droplets, the incubation period for Coronavirus ranges from 2-14 days [7]. Chest X-ray (CXR) examination is the main imaging modality for establishing Covid-19. The results of a chest X-ray examination can be normal or mild at the start of the disease, which is only

visible infiltrates at the base of the lung. After 10-12 days after the onset of symptoms, the chest X-ray will become heavier, ground glass opacity and consolidation that expands in both lung fields [8].

A good radiograph is needed, so that it can be used as a support for the diagnosis of the disease suffered by the patient. Quality is determined by several components, including: density, contrast, sharpness, and detail so that it can be used as a support for the diagnosis of the disease suffered by the patient. The use of digital radiography such as computed radiography (CR) can produce images easily, quickly, optimally, and can be processed as needed. CR is the process of changing the analog system in conventional radiography to digital radiography [1]. In the Computed Radiography system, analog data is converted into digital data during the energy generation stage which is trapped in the imaging plate using a laser, then digital data in the form of signals is captured by the Photo Multiplier Tube (PMT) then the light is multiplied and its intensity amplified after that converted into electrical signals which will be converted into digital data by Analog Digital Converter (ADC). CR has many advantages compared to conventional radiography, its being able to process images printed on film as desired without re-shooting. In a CR system, analog data is converted into digital data by Analog Digital Converter (ADC) [9].

In CXR using CR, it is possible that clinical acquisitions can produce low quality digital images [10]. In this study, digital images from CR are calculated grayscale values and display histogram graphs using imageJ software which is expected to help interpret CXR images in the diagnosis of Covid-19 disease.

2. METHOD

The design of this study is a quantitative approach to the type of experimental research. The number of samples in this study were 18 images of CXR postero-anterior projection patients in each group (covid-19 CXR and normal CXR).

Quantitative chest image assessment was carried out to analyze differences in grayscale and histogram value information on chest images between adult patients suffering from Covid-19 and normal adult patients as a comparison. The calculation of these values is done using imageJ software which includes histogram analysis and grayscale values. The image is analyzed by determining the region of interest (ROI) of 1 cm^2 in the area of the lung base level in the inferior lobe and areas where there are fog/gloomy spots due to pathology. Next, a histogram analysis of the image is performed so that the average grayscale value and standard deviation can be obtained. Calculation of the grayscale mean value and standard deviation between the chest images of Covid-19 and normal patients using the Independent T-test of difference.

3. RESULTS AND DISCUSSION

The characteristics of the age and sex of the respondents were analyzed univariately. These criteria relate to the association with the incidence of Covid-19 disease and the risk of exposure to the disease. Age which is one of the most influential individual characteristics on the level of exposure to this virus, as well as the magnitude of the risk as well as resistance to the Covid-19 virus [11]. Host factors are the key to determining the severity and development of the disease can be found only in one particular sex [12].

Table 1. Frequency Distribution of Responden's Age an Sex

Image	Sex		Age (Mean±SD)
	Male	Female	
CXR Covid-19	12 (66.67%)	6 (33.33%)	41.4±1.76
CXR Normal	12 (66.67%)	6 (33.33%)	39.3±2.37

Based on table 1, it is found that from 18 respondents, male respondents more than female. and the average Covid sufferer is a late adult patient category.Various studies have shown that age and gender are related to the incidence of Covid-19 [13]. The research results obtained by Rinaldi (2021) said that

there was a correlation between gender and the incidence of Covid-19. The researcher revealed that men have a greater chance of contracting Covid-19 than women [14]. It was revealed that due to the reduction in the number of B cells in males as they get older it results in a lack of supply of antibodies so that it can become a weakness in one's ability to fight the SARS-CoV-2 virus [15].

The following is a comparison between the chest images of Covid-19 patients and normal chest images (see Figure. 1):

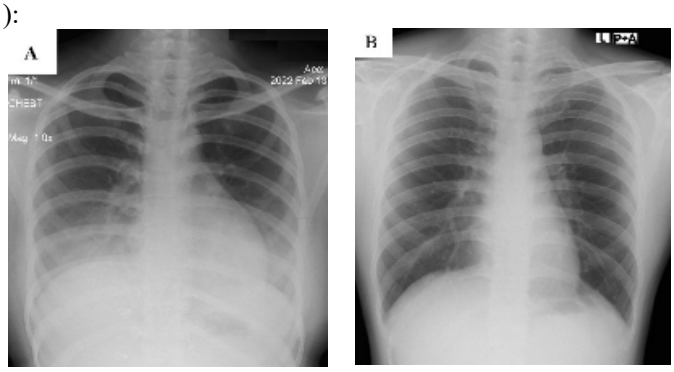
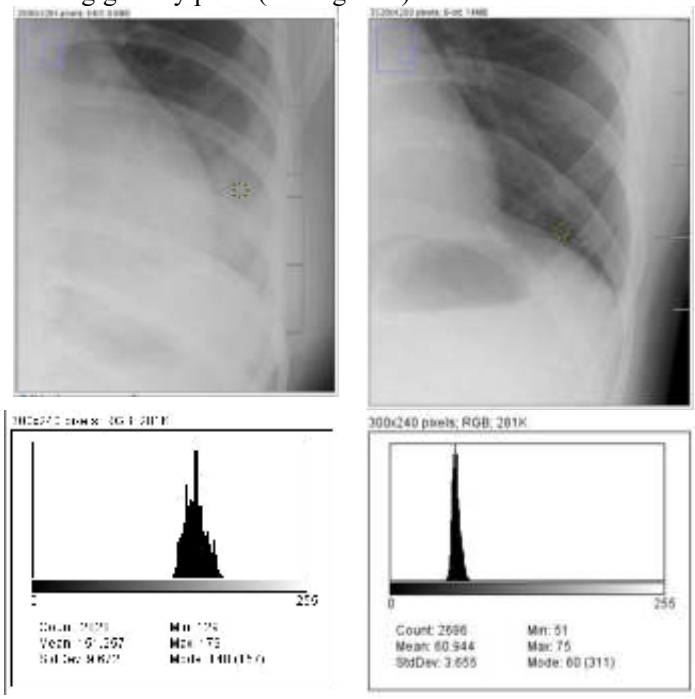


Figure 1. CXR covid-19 image (A); CXR normal image (B)

Based on Figure.1 CXR covid-19 shows the presence of fog or gloom in the lung area. then measurements are carried out by giving ROI in the area of the lung base level in the inferior lobe and the area where there is a fog/gloomy point (see Figure.2).



(A) (B)

Figure 2. Determination of the ROI on the CXR Image and the results of the histogram graph, covid-19 (A); normal (B)

The results of the calculation of the grayscale average value of the covid-19 chest image have a greater value compared to the normal image.

Table 2. Average Grayscale Value of Covid-19 and Normal Chest Images

No	Grayscale CXR Covid-19 Images		Grayscale CXR Normal Images	
	Mean	Deviation Standard	Mean	Deviation Standard
1	110.810	6.978	75.754	4.551
2	92.435	3.434	55.085	3.307
3	151.257	9.672	60.944	3.655
4	113.314	7.869	65.897	2.354
5	138.649	5.631	69.562	3.785
6	148.470	3.295	64.435	2.490
7	95.097	4.602	71.256	4.896
8	111.659	3.179	72.892	3.741
9	90.792	3.617	59.562	2.467
10	122.639	3.060	59.567	3.569
11	110.000	2.684	61.694	4.412
12	86.093	3.430	60.456	2.390
13	127.523	4.178	73.890	2.318
14	128.389	3.575	56.479	3.479
15	125.343	2.338	61.224	3.645
16	114.023	4.158	67.892	2.367
17	135.775	3.152	68.471	3.261
18	111.522	2.795	69.089	2.782
average	**117.433**	**4.314**	**65.231**	**3.304**

An independent T-Test statistical test analysis was carried out to determine the difference in the grayscale mean value and standard deviation between the chest images of Covid-19 patients and normal. The results of the statistical test, there is a significant difference in the Covid-19 and normal chest images with a p-value <0.001.

In this study, the histogram of a normal chest image shows a graph that tends to approach towards the left in black. The histogram of the thorax covid-19 image shows a graph that tends to approach towards the white right. According to Nabuasa (2019), in his research he stated that image histograms that collect in dark areas have dim images. Image histograms that accumulate in bright areas or are concentrated at high image intensities display bright images [16]. In terms of the grayscale average on the PA chest image of patients with Covid-19 and normal patients, there is a significant difference. In this study, the grayscale average in the Covid-19 chest image has a higher value (117.433 ± 4.314) compared to the normal image (65.231 ± 3.304).

Image histogram is a graph that describes the distribution of pixel intensity values of an image or a particular part of the image. From a histogram it can be seen the frequency of occurrence of the relative (relative) image. The histogram can also show a lot about the brightness and contrast of an image. Therefore, the histogram can be used as an image processing method that works both qualitatively and quantitatively [17].The grayscale value range is a digital image that has an intensity value range of 0 (black) to 255 (white). This range can be used to present radiographic medical images and to recognize objects contained in these images [18].

The shift in the histogram graph between those who suffer from Covid-19 and normal, also the increase in grayscale values on CXR Covid-19 is caused by ground glass opacity (GGO), consolidation, nodules, pleural effusion and pneumothorax [19]. GG opacification shows increased areas of haziness or opacification in the lungs [20]. Meanwhile, lung consolidation is a finding characterized by the presence of radiopaqueness in the lungs due to the presence of fluid or material in the pulmonary

airways. Lung nodules may produce rounded opacity on images and up to 3 cm in diameter. the accumulation of fluid between the parietal and visceral pleura (pleural cavity) on chest images also results in an increased radiopaque appearance and a meniscucs sign will appear on image [21]. Meanwhile, normal lungs will appear like a sponge which should be filled with air and when photographed using x-rays a relatively black shadow (radiolucent) will form. However, due to the Covid-19 virus material, the lungs are filled with other material which results in increased tissue density in the lungs compared to normal lung tissue which affects the grayscale value to be higher.

In imaging, the terms radiolucent and radioopaque can relate to tissue density or tissue capacity. The more radiolucent the image, the less dense the existing tissue or changes in structure to become more fluid, approaching the density of water or air. The information on the distribution of gray levels is very useful for separating objects from the background of an image [22]. In addition, analysis of grayscale values and histogram graphs is very helpful in establishing the diagnosis of Covid-19. The histogram shows information on the frequency of use of the gray level in an image. The histogram of an image is very helpful in differentiating the diagnosis of an abnormality. An increasing in the grayscale value, it can be seen how much the level of network density is caused by the Covid-19 disease which results in opacity in the image.

4. CONCLUSION

There is a significant difference in the histogram and grayscale values between CXR covid-19 and normal images. The histogram of the Covid-19 chest image shows a graph that tends to approach more towards the white right. The grayscale value, in the chest image of a Covid-19 patient, has a higher grayscale value than the normal chest image. Histogram analysis and grayscale values are very helpful in establishing the diagnosis of COVID-19, because the assessment is based on histogram differences and changes in grayscale values in the examination image.

REFERENCES

[1] B. W. Long, J. H. Rollins, and B. J. Smith, *Merrill's Atlas of Radiographic Positioning and Procedures*, THIRTEENTH EDITION. St. Louis, Missouri, 2016.

[2] T. Zhang, Q. Wu, and Z. Zhang, "Probable Pangolin Origin of SARS-CoV-2 Associated with the COVID-19 Outbreak," *Curr. Biol.*, vol. 30, no. 7, pp. 1346–1351.e2, Apr. 2020, doi: 10.1016/j.cub.2020.03.022.

[3] C. Huang *et al.*, "Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China," *Lancet*, vol. 395, pp. 497–506, Feb. 2020, doi: 10.1016/S0140-6736(20)30183-5.

[4] M. Bassetti, A. Vena, and D. R. Giacobbe, "The novel Chinese coronavirus (2019-nCoV) infections: Challenges for fighting the storm," *European Journal of Clinical Investigation*, vol. 50, no. 3. Blackwell Publishing Ltd, Mar. 01, 2020. doi: 10.1111/eci.13209.

[5] N. Chen *et al.*, "Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study," *Lancet*, vol. 395, no. 10223, pp. 507–513, Feb. 2020, doi: 10.1016/S0140-6736(20)30211-7.

[6] Kemenkes RI., *Profil Kesehatan Indonesia*. 2021.

[7] T. Singhal, "A Review of Coronavirus Disease-2019 (COVID-19)," *Indian Journal of Pediatrics*, vol. 87, no. 4. Springer, pp. 281–286, Apr. 01, 2020. doi: 10.1007/s12098-020-03263-6.

[8] H. Yuen Frank Wong *et al.*, "Frequency and Distribution of Chest Radiographic Findings in COVID-19 Positive Patients," *RSNA*, vol. 296, no. 2, 2020, doi: https://doi.org/10.1148/radiol.2020201160.

[9] F. Anita and D. A. Tunggadewi, "Uji Banding Citra Film Terhadap Computed Radiography (CR)," *J. Ilm. Giga*, vol. 23, no. 1, p. 20, 2020, doi: 10.47313/jig.v23i1.866.

[10] N. Ahmaed and A. Hadinegore, "Metode Histogram Equaliization untuk Perbaikan Ciitra Diigital," *Seminar Nasional Teknol. Informasii Komuniikasi Teraapan*, vol. 3, no. Semantik, pp. 439–445, 2020, [Online]. Available: http://publikasi.dinus.ac.id/index.php/semantik/article/view/185

[11] D. Arini, S. Kulsum, A. Citra, M. Stikes, and H. T. Surabaya, "Status Kelengkapan Imunisasi Difteri Pada Kejadian Difteri Di Wilayah Surabaya," *J. Ilm. Keperawatan Stikes Hang Tuah Surabaya*, vol. 15, no. 2, 2020, [Online]. Available: www.journal.stikeshangtuah-sby.ac.id
[12] Y. Chen *et al.*, "Aging in COVID-19: Vulnerability, immunity and intervention," *Ageing Res. Rev.*, vol. 65, Jan. 2021, doi: 10.1016/j.arr.2020.101205.
[13] M. L. Daud, J. E. Nelwan, and B. T. Ratag, "Hubungan Antara Umur Dan Jenis Kelamin Dengan Kejadian Coronavirus Disease-19 Di Kota Bitung Tahun 2020," *J. KESMAS*, vol. 11, no. 1, pp. 190–195, 2022.
[14] R. N. Rinaldi, "FAKTOR RISIKO YANG BERHUBUNGAN DENGAN KEJADIAN COVID-19 DI KOTA BOGOR," Universitas pembangunan Nasional Veteran Jakarta, Jakarta, 2021.
[15] M. A. A. Al-Bari, S. Hossain, and M. K.-E. Zahan, "Exploration of sex-specific and age-dependent COVID-19 fatality rate in Bangladesh population," *World J. Radiol.*, vol. 13, no. 1, pp. 1–18, Jan. 2021, doi: 10.4329/wjr.v13.i1.1.
[16] Yelly N Nabuasa, "PENGOLAHAN CITRA DIGITAL PERBANDINGAN METODE HISTOGRAM EQUALIZATION DAN SPESIFICATION PADA CITRA ABU-ABU," *J-ICON*, vol. 7, no. 1, pp. 87–95, Mar. 2019.
[17] Dodi Andre Putra, J. Na` am, and Yuhandri, "Identifikasi Objek pada Citra Thorax X-Ray Pasien COVID-19 dengan Metode Contrast Limited Adaptive Histogram Equalization (CLAHE)," *J. Inf. dan Teknol.*, pp. 33–38, Feb. 2022, doi: 10.37034/jidt.v4i1.184.
[18] M. Aprilian, S. H. Sitorus, and U. Ristian, "PERBANDINGAN METODE GABUNGAN HISTOGRAM EQUALIZATION DENGAN CONTRAST STRETCHING UNTUK PERBAIKAN KUALITAS CITRA RADIOLOGI," *Coding J. Komput. dan Apl.*, vol. 08, no. 02, pp. 55–66, 2020.
[19] E. Cozzi *et al.*, "COVID-19 pneumonia in lung transplant recipients: Report of 2 cases," *Am. J. Transplant.*, vol. 20, no. 10, pp. 2933–2937, Oct. 2020, doi: 10.1111/ajt.15993.
[20] F. Albarello *et al.*, "2019-novel Coronavirus severe adult respiratory distress syndrome in two cases in Italy: An uncommon radiological presentation," *Int. J. Infect. Dis.*, vol. 93, pp. 192–197, Apr. 2020, doi: 10.1016/j.ijid.2020.02.043.
[21] K. Loverdos *et al.*, "Lung microbiome in asthma: Current perspectives," *Journal of Clinical Medicine*, vol. 8, no. 11. MDPI, Nov. 01, 2019. doi: 10.3390/jcm8111967.
[22] L. Epsilawati, S. Sitam, S. Belly, and F. Oscandar, "Analisis gambaran histogram dan densitas kamar pulpa pada gigi suspek pulpitis reversibel dan ireversibel dengan menggunakan radiografi cone beam computed tomography," *Dentofasial*, vol. 13, no. 2, pp. 122–128, 2014.