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Superoxide Dismutase (SOD) Level in Blood of the People Living in High and Lowest Radon Exposure Area: A Study in Padalarang, West Java Indonesia

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Abstract: Radon^{222} released from rocks contribute to the level of radiation in human body. The stratigraphy of West Java, which is dominated by granite, has a high level of radon. The result of the study in Padalarang shows that the highest dose of radon is 24 Bq/kg and the lowest 17 Bq/kg. The alpha rays may affect the Superoxide Dismutase (SOD) level. The research is conducted on all men and women in the age of 30 to 70 living in Padalarang district who met the inclusion criteria, with good general health condition, being original inhabitant since birth, not suffering from chronic systemic infectious diseases, and willing to participate in the research by completing the informed consent. Sample is taken by using consecutive sampling. Blood sample is taken as much as 2 cc/person by using a 2cc syringe, which is then inserted into venoject tube containing heparin. Antioxidant activity in the blood plasma is examined by using SOD Kit. The average of SOD level is 3.56 ui/ml in Highland (Masigit Mountain) and 1.65ui/ml in lowland (Cipatat). The increase of SOD level of the people living in Highland is suspected to be the contribution of radon exposure contained in rocks and water.

Key words: Radon, highland, superoxide dismutase (SOD).

1. Background

Radon^{222} released from rocks contributes to the level of radiation in human body. The negative and positive impact of long-term radiation on health has been proven through epidemic studies [1, 2]. Radon comes from the decay of radioactive originated from rocks and soils which contain uranium. Geology contributes to the determination/limitation of areas with rising radon exposure in soil and rocks [3, 4]. The level of radon from external and internal sources is considered high. For example, in the United States, the average levels of radon each year is about 3 mSv [5]. It makes radon as the largest contributor of natural ionizing radiation, as much as 83%. While artificial radiation only contributes 0.60 mSv at the maximum or 17% of natural ionizing radiation.

Unlike in developed countries like USA, Australia, and Japan, radon gas monitoring in the environment, homes and offices in Indonesia has not been given serious attention. Though based on the geographic data, Indonesia is one of the areas with great radon potential.

In an environment which could potentially contain radon, alpha particle is emitted by radon^{222} through air and water. Radon in homes, which may become the basis of alpha wave, can reach 20 times higher than its source [6, 7]. If alpha wave, an ionizing radiation, indirectly interacts with the tissue or molecules, usually through water, it will produce free radicals Hydrogen (H), hydroxyl (OH). When this happen, hydrogen peroxide, which is highly reactive, can be formed. Free radical, such as reactive oxygen species (ROS) and reactive nitrogen species (RNS), is the byproduct of normal metabolism of oxygen [8].

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The stratigraphy of West java, which is dominated by granite, has a high level of radon. The result of the study in Padalarang shows that the highest dose of radon is 24 Bq/kg and the lowest 17 Bq/kg. Specifically, the dose of radon in plateau (Gunung Masigit) is 24 Bq/kg and in lowland (Cipatat) is 17 Bq/kg [9]. People in Gunung Masigit have low socioeconomic level. They build their homes with minimal ventilation and use cement plaster mixed with limestone soil for their floor. Argues that accounting geology and soil radon is useful in measuring the of radon levels in home [10].

The primary antioxidant in the body is superoxide dismutase (SOD). This enzyme is very important due to its ability to protect cells in the body from free radicals. The effect of free radical can be detected by assessing the SOD activity. The purpose of this research is to identify the SOD level in groups of people living in areas with high and low radon dose.

2. Method

The population in this research is conducted on two groups of people living in different villages in Padalarang district with different radon level based on the stratigraphy analysis, namely Gunung Masigit (Highland) and Cipatat (lowland). This research is conducted on all men and women in the age of 30 to 70 year living in Padalarang district who met the inclusion criteria, with good general health condition, being original inhabitant since birth, not suffering from chronic systemic infectious diseases, and willing to participate in the research by completing the informed consent; and followed up by recording of basic data including: age, weight, height, and history of systemic disease. Sample is taken by using consecutive sampling; data is collected based on the willingness of subject, until the minimum number is fulfilled. Blood sample is taken as much as 2 cc/person by using a 2 cc syringe, which is then inserted into venoject tube containing heparin. Blood separation is carried out by using centrifugation. Plasma is taken by using a Pasteur pipette, then is stored at a temperature of -8 ℃ until plasma malondialdehyde (MDA) level analysis is conducted. Erythrocyte is isolated from granulocyte by washing it by using 3 mL of physiological sodium chloride (NaCl). Then centrifuge the samples at 3,000 rpm for 10 minutes. Erythrocyte is washed with cold distilled water as much as 2 mL, and then stored at 4 ℃ for 15 minutes. After that, it is then resuspended with phosphate buffer 0.01 mol/L, pH 7. After that, the erythrocyte is ready to use for SOD activity test.

3. Result and Discussion

Research is conducted on 60 people aged 30 to 70 years old. Four people are executed due to blood lysis. To 56 subjects who fulfilled the inclusion criteria, basic data is recorded including: age, sex, occupation, and smoking and non-smoking information. There are 29 people living in plateau and 27 in lowland consisted of men and women. Most of the samples work as housewives and the rest work as labor and temporary employees as seen on Table 1.

Female is more than male. There are 40 female and 16 male. The majority works as housewives which most of their time spent at home.

Blood antioxidant level is examined by using SOD kit. Result of the examination is divided based on location, as seen in Table 2.

4. Discussion

The radon dose in the Highland (Gunung Masigit) is 24 Bq/kg, mean while in lowland (Cipatat) is 17 Bq/kg.

Table 1 Sample characteristics.

Characteristic	Description	Number
Location	Highland	29
	Lowland	27
Sex	Male	16
	Female	40
Occupation	Teacher	3
	Civil servant	2
	Housewife	30
	Farmer	14
	Entrepreneur	7

Table 2 Distribution of SOD level based on location.

Plateau			Lowland		
No.	Age	Unit/ml	No.	Age	Unit/ml
1	66	1.30	1	49	1.47
2	54	1.13	2	38	1.63
3	68	1.80	3	32	1.13
4	39	1.13	4	39	0.97
5	40	1.80	5	60	3.97
6	63	1.80	6	42	1.30
7	22	1.63	7	45	2.97
8	69	3.30	8	50	0.97
9	55	2.80	9	52	1.97
10	51	2.63	10	61	0.97
11	47	2.30	11	51	0.97
12	56	2.97	12	37	0.13
13	39	2.63	13	60	0.30
14	46	3.63	14	25	0.63
15	63	3.63	15	42	0.80
16	41	2.63	16	36	0.30
17	43	3.13	17	30	1.13
18	37	3.13	18	30	3.13
19	32	2.30	19	70	3.13
20	38	4.30	20	31	1.80
21	34	3.97	21	41	3.47
22	47	3.63	22	25	3.13
23	25	3.47	Average		3.13
24	21	3.63			
25	50	2.63			
26	30	8.30			
27	45	8.30			
28	24	6.80			
29	36	6.30			
30	25	5.13			
31	40	3.63			
32	43	4.80			
33	43	5.13			
34	46	5.30			
Average		3.56			

Plasma SOD levels of the people living in High land is higher on average than those of the people living in lowland.

Gallego et al. [10] argue that accounting geology and soil radon is useful in measuring the concentration of radon levels in home. Radon in homes, which may become the basis of alpha wave, can reach 20 times higher than its source. Radon gets into the body through the air and drinking water then it is carried by the bloodstream and accumulates in the tissues, especially those of bone and tooth. According to WHO, the accumulated radon in bone and tooth can be used as marker [11, 12].

Alpha particle emitted early by radon can affect blood, kidney, liver, spleen, and brain [13, 14]. From the study, it is known that most of the people living either in High land (with the radon level of 24 Bq/kg) or in lowland (with the radon level of 17 Bq/kg) are

women who work inside home [8].

As mentioned in background, radon^{222} released from rocks contributes to the level of radiation in human body. The negative impact of long-term radiation on health has been proven through epidemic studies. Radon comes from the decay of radioactive originated from rocks and soils which contain uranium. Geology contributes to the determination/limitation of areas which radon exposure emits alpha particle [15, 16]. Based on that, alpha radiation in Highland is suspected as one of the factors which contribute to the increase of SOD level [17]. The increase of SOD level in Highland is a proof that many ROS are produced and circulating in the blood vessels. Alpha waves have low permeability and high ionization which can produce many ROS and induces SOD antioxidant.

SOD is the major intracellular antioxidant enzyme that can be used to neutralize the reactive activity. If alpha wave, an ionizing radiation, indirectly interacts with the tissue or molecules, usually through water, it will produce free radicals Hydrogen (H), hydroxyl (OH). When this happen, hydrogen peroxide, which is highly reactive, can be produced. Free radical, such as reactive oxygen species (ROS) and reactive nitrogen species (RNS), is the byproduct of normal metabolism of oxygen. Radical compounds containing unpaired electrons will stimulate the body to secrete free radical scavenging enzyme. In this case, the most responsible enzyme is SOD, glutathione and catalase [13, 14]. High radon level which is continuously exposed through inhalation and water will get into the bloodstream and produce free radical as well as reactive oxygen which will stimulate SOD activity. Generally, all SODs use metal ions to catalyze dismutase O_2 through the mechanism of oxidation-reduction. SOD neutralizes O_2- to oxygen and hydrogen catalase and glutathione peroxidase. Low dose of alpha particle induces the production of ROS which then will induce the production of SOD and catalase. This activity inhibits several oxidative injuries such as hepatopathy and ischemia-reperfusion injury [14, 18].

Thermal therapy by using radon gas can increase SOD activity and CD4+ which is the marker for T helper cell and can decrease CD8 [20, 21]. In line with this research, in a certain step, radon increases SOD and has positive effect to health. Likewise, in the study on mice with radon gas treatment, there is an increase of SOD activity in blood, kidney, liver and spleen in the first four hours. After that, there is a decrease of the activity in the next sixteen hours, meanwhile blood SOD remains high [17]. This happens because blood receives radon from all tissues before it is accumulated in the blood vessels. Some experiments show the increase of blood SOD level, whereas in cataract lens, there is a decrease of SOD level [14]. Research on the experiment group shows that low dose of radon has anti-inflammatory effect which can reduce pain. Based on the result of this research, alpha particle radiation with the dose of 24 Bq/kg exposed from the environment can increase SOD level.

ROS can be produced by cell in stress and non-stress condition. In the later condition, there is balance between the production process and extermination of ROS. Meanwhile in the former condition, the production of ROS is higher than the extermination. As a result, the immune system is stimulated to work hard and exterminate ROS. Enzymatic and non-enzymatic antioxidant is a defense system which suppresses ROS excessively [19-21].

Thus, it can be assumed that radon in rocks and water contributes to the increase of SOD level in Highland. The weaknesses of this research are: this research is only presented descriptively, uncontrolled confounding factors still exist, and this research uses limited number of sample.

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