



## Effects of Dietary Antioxidant Intake on Lung Functions in Construction Workers in Surabaya

Amelia Lorensia<sup>1</sup>✉, Rivan Virlando Suryadinata<sup>2</sup>, Ikhwan Khairul Mahfidz<sup>1</sup>

<sup>1</sup>Pharmacy Faculty, University of Surabaya, Jl. Raya Kalirungkut, 60293 Indonesia

<sup>2</sup>Medical Faculty, University of Surabaya, Jl. Raya Kalirungkut, 60293 Indonesia

### Article Info

*Article History:*  
Submitted October 2020  
Accepted May 2021  
Published July 2022

*Keywords:*  
antioxidant, smoker,  
constructive workers,  
FEV1/FVC

**DOI**  
<https://doi.org/10.15294/kemas.v15i2.14349>

### Abstract

Oxidative stress is a condition where the imbalance between oxidants and antioxidants in the body. Vitamins A, C, and E are antioxidants that can inhibit the activity of antioxidant compounds so that these levels become balanced. The research purpose is to know the difference in intake of antioxidants in the diet and the intake effect on lung function in mason who suffer from respiratory and who do not suffer from respiratory. The study design was observational methods Retrospective with purposive and consecutive sampling. Measured variables such as vitamin A, C, and E to Recall 24h and conditions of lung function. Namely % FEV1 and FVC% with a handheld spirometer. The study sample consisted of 79 people who suffer from respiratory and 79 without respiratory distress. The results showed no significant difference between antioxidant intake in the group of interference and without interference ( $p < 0.05$ ). Artifacts relationship between antioxidant intake with lung function ( $\text{sig.} > 0.05$ ). Intake of vitamin A on lung function has a value of  $p = 0.05$ , which means associated with lung function but are very weak correlation (correlation coefficient value  $-0.036$ ) while vitamin C and E have a value of  $p = 1.000$ , which means there is a relationship and is a very weak correlation (correlation coefficient value of  $-0.036$ ). The results showed no significant difference between antioxidant intake in the group of interference and without interference ( $p = < 0.05$ ). Artifacts relationship between antioxidant intake with lung function ( $\text{sig.} > 0.05$ ). Intake of vitamin A on lung function has a value of  $p = 0.05$ , which means associated with lung function but are very weak correlation (correlation coefficient value  $-0.036$ ) while vitamin C and E have a value of  $p = 1.00$ , which means there is a relationship and is a very weak correlation (correlation coefficient value of  $-0.036$ ). The results showed no significant difference between antioxidant intake in the group of interference and without interference ( $p < 0.05$ ). Artifacts relationship between antioxidant intake with lung function ( $\text{sig.} > 0.05$ ). Intake of vitamin A on lung function has a value of  $p = 0.05$ , which means associated with lung function but are very weak correlation (correlation coefficient value  $-0.036$ ) while vitamin C and E has a value of  $p = 1.00$ , which means there is a relationship and is a very weak correlation (correlation coefficient value of  $-0.036$ ).

### Introduction

The process of building physical infrastructure and social institutions produces various kinds of pollutants, such as pollution and fine dust, which will have a negative impact, especially on the health of the construction workers. The pollutions and fine dust generated by the construction of infrastructure and social institutions usually come from concrete, stone, cement, and wood, which will have an

impact in the long term. The dust particles in construction are classified as very small particles, less than 10 microns and cannot be seen directly or are classified as PM10. The high exposure received by construction workers can increase the risk of respiratory problems such as asthma (Schulze et al., 2017), and chronic obstructive pulmonary disease (COPD) (GOLD, 2018; Zhu et al., 2013), and lung cancer (Consonni et al., 2018). Exposure to indoor and

✉ Correspondence Address:  
Pharmacy Faculty, University of Surabaya, Jl. Raya Kalirungkut, 60293 Indonesia.  
Email : amelia.lorensia@gmail.com

outdoor air pollution, dust, and smoke received by workers, namely construction workers, is a risk factor for respiratory problems (Jiang et al., 2016). Workplace pollution such as organic dust (vegetable dust and bacteria or toxins from the textile industry (dust from cotton) and industrial environments (mining, iron and steel industry, wood industry, building construction), chemical paint factories, inks, etc. are estimated at 19% (Oemiati, 2013).

Apart from pollution, respiratory problems are also exacerbated by several risk factors. Namely cigarette smoke, air pollution, oxidative stress, genes, lung growth and development, and economic status. Oxidative stress causes damage to the lungs and also causes molecular activity to initiate pulmonary inflammation. So, the imbalance between oxidants and antioxidants plays a vital role in COPD pathogenesis (Domej et al., 2014). Cigarette smoke is one of the largest sources of exogenous free radicals. Free radicals are reactive oxygen compounds which are compounds with unpaired electrons. The compound or atom tries to reach a stable state by attracting other electrons to form new radicals (Phaniendra et al., 2015). Molecules that contain one or more unpaired electrons and thus give reactivity to molecules are called free radicals. When two free radicals share unpaired electrons, they form a nonradical form (Lobo et al., 2010). Neutrophils and macrophages that enter the lung tissue are key roles in reactive oxygen species (ROS) production to increase the induced nitric oxide (NO). Later, ROS causes oxidative damage to protein, lipid, DNA, and carbohydrate cells. Shifting the balance between oxidants and antioxidants in favor of oxidants is called oxidative stress. Oxidative stress contributes to various pathological conditions and diseases, including cancer, neurological disorders, atherosclerosis, hypertension, ischemia or perfusion, diabetes, acute respiratory distress syndrome, idiopathic pulmonary fibrosis, chronic obstructive pulmonary disease, and asthma (Birben et al., 2012). Oxidative stress contributes to permanent damage to both parenchyma and airway walls and activates molecular mechanisms that initiate lung and systemic inflammation and also to atherosclerosis (Pizzino et al., 2017).

Antioxidants can stop cell damage by giving electrons to free radicals. Antioxidants will neutralize free radicals so that they no longer can take electrons from cells and DNA (Lobo et al., 2010). Apart from supplements, intake of foods containing antioxidants, such as consumption of fruits and vegetables, can also provide benefits for acute and chronic respiratory conditions because fruits and vegetables contain antioxidants, minerals, vitamins, flavonoids, and fiber (Slavin and Lloyd, 2012; Berthon and Wood, 2015).

This study compares the intake of antioxidants in food among construction workers in Surabaya who already have respiratory problems and those who don't. The assessment of respiratory disorders was derived from the value of lung function. The pulmonary function can be measured with a spirometer on the spirometry method and peak flow meter (GOLD, 2018). Spirometry is the most objective method and can be done repeatedly in measuring airflow limits. Spirometry measures the air volume forcibly exhaled from the point of maximum inspiration (forced vital capacity, FVC), the volume of air exhaled during the first one second (forced expiratory volume in one second, FEV1), and the FEV1/FVC ratio (GOLD, 2018; Lorensia et al., 2018). Food can affect lung function health (Indraswari et al., 2018).

Antioxidant intake in the diet can be measured by a 24-hour recall method. The 24-hour recall method is carried out to determine food consumption quantitatively by examining it several times or several days to provide a picture of the actual consumption. The 24-hour recall method is used because this method is relatively easy to do, has a minimal burden on respondents, and only requires a relatively short time for one interview, namely 20-30 minutes (Shim et al., 2014). Research conducted by Pratiwi et al. (2018) in analyzing the level of antioxidant intake in the form of vitamins C and E. The vitamins are also widely contained in foods and can affect lung function in smokers and non-smokers. There were differences in vitamin C and E intake, the lung function of a smoker and non-smoker, and the effect of Vitamin C and E intake on lung function. Based on the background and problem formulations

above, the aim of this study was to determine the relationship between antioxidant intake (vitamins A, C, and E) in food and lung function in construction workers in Surabaya.

## Method

This study is an observational study using a retrospective study design to detect the risk of chronic obstructive pulmonary disease due to oxidative stress as seen from the intake of antioxidants from food with a 24-hour recall of construction workers. The research location used in this study is in the Surabaya area. This research was conducted in March-June 2019, with ethical approval no. 005-OL/KE/V/2019 in Universitas Surabaya

The variable in this study was impaired respiratory function, while the dependent variable is the intake of foods containing antioxidants (vitamin A, C, and E). The construction worker referred to in this research was a person who works by relying on his physical strength and has the skills in handwork (with certain tools or materials) in making residential buildings and buildings in general (such as buildings). Construction workers in this study included excavators, masons, blacksmiths, carpenters, painters, and helpers.

Food intake was the amount or amount of food individually or in various types consumed by a person or group of people to meet physiological, psychological, and sociological needs. The method of measuring antioxidant intake was by using the 24-hour recall method. Classification of Nutritional Adequacy Rate (Tingkat Angka Kecukupan Gizi), namely: Good (>100% nutritional adequacy rate); Moderate (80 - 99% nutritional adequacy rate); Less (70 - 80% nutritional adequacy rate); and Deficit (<70% nutritional adequacy rate). The nutritional adequacy rate for vitamins A, C, and E uses the guidelines from PERMENKES R1 (2013).

Lung function disorders are diseases and disorders occurred in the respiratory tract and lungs that affect human respiration. Lung function disorders in this study were conditions in which the FEV1 value is <70% in the lung function measurement by spirometry. A person's lung condition can be known through spirometric measurements. If it shows

the results of the FEV1/FVC value <0.7, it can be impaired (GOLD, 2018).

The population used in this study was construction workers in the Surabaya area. Affordable population, namely construction workers who were working on the project. The desired sample to participate in this research is construction workers in Surabaya who meet the following criteria: smoking, 18-60 years old, minimum length of work of 5 years. The sampling technique used is a sampling that does not provide an equal opportunity or opportunity for each member of the population to be selected as a sample (non-probability sampling), with purposive sampling and consecutive sampling methods. The number of samples taken in this study uses the Lemeshow formula because the population size is unknown or infinite. The following was Lemeshow's formula, namely:

$$n = \frac{Z^2 \cdot 1 - \frac{\alpha}{2} \cdot P(1 - P)}{d^2}$$

n : Number of samples

$z^{2 \cdot 1 - \alpha/2}$  : Normal standard value (if  $\alpha=0.05$ , then  $z=1.96$ )

P(1-p) : estimated population proportion (if P=0.5, then P(1-p)=0.25)

d : tolerable deviation (10%)

Based on the results of the above calculations, the sample size set in this study was 62 respondents, so the researcher had to collect at least 62 respondents.

This study used a structured interview method, where the first 10 respondents were given guidance by a nutritionist in data collection. The data collection work steps were as follows: 1) Collect research subjects.; 2) The pulmonary function test of respondents using the spirometry method was carried out. The respondents would later be divided into two groups, namely "without lung function disorders group" and "with lung function disorders group". In this study, a validated handheld spirometer was used with the brand Contec Handheld SP10 Spirometer. When using a handheld spirometer, age, gender, weight, and height, including smokers or non-smokers.

The respondent was asked to stand or sit upright. Then the respondent took a deep breath through the mouth while covering the nose. The tube contained in the spirometer was inserted into the mouth, make sure the lips were tightly closed against the tube wall, and

the tongue did not cover the tube opening, then breathe exhaled as hard and as fast as possible in one second until there was no air left in the lungs (GOLD, 2018; Lorensia et al., 2018).; 3) Measurement of antioxidant intake (1st, 2nd, and 3rd). Data collection of antioxidant intake in food was carried out using the 24-hour recall method as an interview guide for measuring food consumption in preparing interview questions.

The 24-hour recall method was used to determine the food and drink consumed during the previous 24 hours, examining it for several times or several days to provide an overview of the actual consumption of the examined respondents. The 24-hour recall method was carried out three times but not consecutive times, namely two times on weekdays and one holiday because this scheme can describe the variability of calorie and nutrient intake. The first meeting took place on a weeknight. The second meeting was on the following working day with an interval of at least two days from the first meeting. The third meeting was on Sundays or holidays, at least two days apart from the second meeting. In the 24-hour recall method, was questioned about all food and drinks consumed in the past 24 hours, including portion sizes, with the help of a photo of household sizes, such as spoons, plates, cups, or other sizes commonly used daily as shown in the Food Photo Book (PERMENKES RI, 2013). Then the results were equalized to the average daily intake. The data obtained in this study were primary data obtained directly from research subjects through direct dialogue (interviews).

The steps for data collection using the 24-hour recall method were as follows: Respondents were asked what time they last consumed food or drinks during the recall; Then the respondents were asked about the food and drink they consumed during the previous 24 hours from the last time they consumed food and drinks at the time of the recall; The Food Photo Book (PERMENKES RI, 2013) was shown to respondents to ask about the portions of food and drinks consumed.; 4) The data collected is in the form of household sizes would be processed to obtain data in

the form of calorie intake using the program Nutrisurvey. Nutrisurvey was a powerful software for analyzing food nutrients from a menu or consumption survey. For example, to find the antioxidant intake obtained when consuming chili sauce, namely by opening the Nutrisurvey software, entering the word "sambal" and then entering the amount in grams asked during the interview.

The data on antioxidant intake in the form of vitamins A, C, and E will appear. After the antioxidant intake data were collected and inputted into the SPSS version 24 program, statistical analysis was carried out. 5) The ordinal scale data was tested using the chi-square test and the ratio with the Kolmogorov-Smirnov normality test. Then followed by an independent t-test to see differences in calorie intake from food in the "without lung function disorders group" and "with lung function disorders group" in construction workers in Surabaya. The Chi-square test was significantly different if the p-value was  $<0.05$ . The data were also tested with the Spearman test to see the relationship between calorie intake from food and lung function in construction workers in Surabaya.

The steps for 24-hour recall data processing are: A direct interview uses a 24-hour recall form. Food and drinks consumed one day or 24-hours earlier were asked using the 24 hour recall form. For example, the respondent said he had previously consumed one spoon of sambal eat. Next is to record the food (chili sauce) and the portion (one tablespoon) on the 24-hour recall form, then the Food Photo Book is shown to the respondent to ask what kind of tablespoon is consumed. After showing which portion of one tablespoon is, the amount of chili sauce in grams is obtained; After the amount in grams is obtained, an analysis of the number of antioxidants in the consumed sauce is carried out using the Nutrisurvey application. In the Nutrisurvey application, enter the word sambal in the "food" column, then the amount in grams in the "amount" column, then the nutritional value will appear in the next columns. The number of antioxidants the white rice contained can be seen in the "vitamins" section of the "total analysis" column.



## Result And Discussion

This research was conducted in May-July 2019 by direct questions and answers (interviews) with respondents using a questionnaire about respiratory disorders to determine the knowledge profile of risk factors, symptoms, and treatment and therapy for respiratory disorders on lung function in construction workers in East Surabaya. Respondent data obtained in this study were 158 masons. They were 79 people with lung function disorders and 79 people without lung function disorders. There were 20 respondents who refused to fill out the questionnaire where 16 people did not want their rest time to be disturbed, and four people did not meet the inclusion criteria.

Respondents in this study were divided into two groups, namely group with impaired lung function and group without lung function disorders. Respondents used in both groups were 158 respondents, with 79 respondents in each group. Respondents' characteristics based on spirometric values  $\alpha$  to see lung function in groups with respiratory disorders, will be classified based on GOLD (2018) into 2, namely mild and worsening. The spirometric value obtained from each respondent will be calculated as the predictive value. We compare the spirometric value of each respondent with the standard FEV1 value of 3.2 liters. Then get the predicted value of each respondent and classify it. In this characteristic, the chi-square test could not be carried out because data was not obtained in the group without lung function disorders. So it could not be compared between the group without lung function disorders and the group with lung function disorders (Table 1). The spirometry value in the group with and without lung function disorders is in Table 2. The average in the group without lung function was 77.51% and in the group with impaired lung function was 63.42%.

Decreased lung function in active smokers was thought to be due to exposure to cigarette smoke. It is exogenous free radicals that can trigger inflammation of the bronchi along the respiratory tract, pulmonary parenchyma, and pulmonary vascular system, affecting limited airflow, thus reducing lung function conditions (Rovina et al., 2013). Another mechanism is

thought to occur due to an imbalance between oxidants and antioxidants. Cigarettes are a source of exogenous oxidants, while endogenous oxidants are from cellular aerobic metabolism in the form of mitochondrial respiration and nicotinamide adenine dinucleotide phosphate (NADPH). The lungs can to neutralize excess ROS levels through cellular antioxidant defense mechanisms. Including superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GSH). Increased levels of free radicals that exceed the ability of cellular antioxidant defenses in the lungs cause oxidative stress, which directly or indirectly causes changes in the structure and function of the airways and lung parenchyma (Kirkham dan Rahman, 2006; Domej et al., 2014). Oxidative stress directly causes the oxidation of deoxyribonucleic acid (DNA), fat, and airway and lung cell membrane proteins.

DNA oxidation results in lung damage and increases the risk of developing lung cancer. Oxidative stress indirectly causes an increased inflammatory response, protease activation and antiprotease inactivation, and cell apoptosis. This process is caused by the activation of redox-sensitive transcription factors and signals transcription, including Nf $\kappa$ B, activator protein1 (AP1), mitogen-activated protein kinases (MAPK), and phosphoinositide 3-kinases (PI3Ks) which regulate several gene transcriptions (Cavalcante and Bruin, 2009; Valavanidis et al., 2013; Rahal et al., 2014). The decrease in lung function of active smokers is thought to be due to the presence of airway remodeling, namely inflammation, fibrosis, and exudate in the small airway lumen with a diameter of <2mm. A decrease in% FEV1 is one of the hallmarks of pulmonary obstruction. Patients with COPD experienced a decrease in the value of% FEV1 by 50-60 mL/year (Cavalcante dan Bruin, 2009).

Several previous studies have suggested that cigarette smoke can inhibit mucociliary clearance. Under normal conditions, the cilia and mucus in the bronchi protect against irritant inhalation, that is, by capturing and expelling them. Continuous exposure to irritants from cigarette smoke over-responds to these defenses. Factors that cause the failure of mucociliary clearance are the proliferation

of goblet cells and the exchange of ciliated and non-ciliated epithelium. Hyperplasia and hypertrophy of the mucus-producing glands cause mucus hypersecretion in the airways. The irritation of cigarette smoke also causes inflammation of the bronchioles (bronchiolitis) and alveoli (alveolitis), as a result of which macrophages and neutrophils filter into the

epithelium and amplify the degree of epithelial damage. The inflammation occurring in chronic bronchitis with mucus excretion and narrowing of the lumen is also followed by fibrosis and irregularity of the small airways, which further narrows the airways. An autopsy showed that patients with chronic bronchitis had an airway diameter of less than 0.4 mm (Sze et al., 2014).

**Table 1. Frequency Distribution of Characteristics of Respondents**

Characteristics	Number of Respondents (n: 158)				P-Value*	
	Without Lung Function Disorders Groups (n: 79)		With Lung Function Disorders Groups (n: 79)			
	Frequency	Percentage (%)	Frequency	Percentage (%)		
<b>Age (years)</b>	Late adolescence (17-25)	20	25.32	15	18.99	0,113
	Early adulthood (26-35)	33	41.77	45	56.96	
	Late adulthood (36-45)	13	16.46	15	18.99	
	Early elderly (46-55)	10	12.66	3	3.79	
	Late elderly (56-65)	3	3.79	1	1.26	
<b>BMI (kg/m<sup>2</sup>)</b>	Thin (<18.5)	7	8.86	6	7.59	0,485
	Normal (18.5-25.0)	59	74.68	66	83.54	
	Overweight (25.0-27.0)	8	10.13	5	6.33	
	Obesity (≥27.0)	5	6.33	2	2.53	
<b>Spirometric Value (GOLD, 2018)</b>	Mild (FEV1 > 80% Predicted)	0	0	66	83.54	[REDACTED]
	Worsening (50% < FEV1 < 80% predicted)	0	0	13	16.46	

\*) P value of Chi-Square test was >0.05, means that there was no difference between without and with lung function disorders groups

**Table 2. Average Value, Highest Value, Lowest Value and Standard Deviation of Spirometric Value**

	Spirometric Value (%)	
	Without Lung Function Disorders Groups (n: 79)	Without Lung Function Disorders Groups (n: 79)
<b>Average Value</b>	77.51	63.42
<b>Highest Value</b>	117.00	69.00
<b>Lowest Value</b>	70.00	37.00
<b>Standard Deviation</b>	7.19	6.32

Table 3. Profile of 10 Most Types of Foods Containing Vitamin A, Vitamin C, and Vitamin E

Food material	Number of Respondents (n: 158)					
	Without Lung Function Disorders			Without Lung Function Disorders		
	Groups			Groups		
	(n: 79)			(n: 79)		
	Vitamin A	Vitamin C	Vitamin E	Vitamin A	Vitamin C	Vitamin E
Fried egg/ omelet	20462.3	0	232.4	16941.6	0	187.2
Spinach	6844.8	92.9	13.5	4607.7	56.0	10.9
Sambal	1286.1	307.5	0	707.5	162.7	0
Sauté the kangkong	1159.6	133.2	9.6	2256	187.2	15.7
Vegetable soup	3830.6	24.3	8.1	7897.6	45.3	23.3
Lodeh soup	1164.0	184.3	29.1	2937.6	549.7	86.1
Fried rice	645.0	0	61.5	650.0	0	65.0
Fried chicken	589.7	0	0	590.4	0	0
Stir-fry the mustard greens	555.6	75.1	4.3	526.4	44.6	4.7
Ote-ote	486.4	0	0	540.3	0	0

Table 4. Profile of Nutritional Adequacy Rate of Vitamin A, C, and E

Antioxidant classification (Vitamin A, C, and E)	Without Lung Function Disorders Groups (n: 79)	Number of Respondents (n: 158)		P Value*
		Without Lung Function Disorders Groups		
		(n: 79)		
Nutritional Adequacy Rate of Vitamin A	Enough (>600 mcg/day)	3	3	0.889
	Less (<600 mcg/day)	76	76	
Nutritional Adequacy Rate of Vitamin C	Enough (>90 mg/day)	0	1	0.987
	Less (<90 mg/day)	79	78	
Nutritional Adequacy Rate of Vitamin E	Enough (>15 mg/day)	1	1	0.987
	Less (<15 mg/day)	78	78	

\*) P value of Chi-Square test was >0.05, means that there was no difference between without and with respiratory disorders groups

In this study, different tests were carried out for the intake of vitamins A, C, and E in the respiratory distress group with the no respiratory disorder group with the chi-square test because the data were ordinal scale. Based on table 4.14, the results obtained on the chi-square test, namely the p-value of 0.889, 0.987, and 0.987. So with a p value > 0.05. It means, no significant difference in the intake of antioxidants in the form of vitamins A, C, and E in the diet in the respiratory disorders group and the group without respiratory disorders. It is per research conducted by Tsiligiani and Molen (2010), where there was no difference in vitamin intake in the impaired and non-impaired groups. This study is similar to that conducted by Pratiwi et al. (2018) shows that test results showed lung function and vitamin

C intake were significantly different (p=0,00), while vitamin E (p=0,29) intake did not differ significantly between active smokers and non-smokers. The results showed the influence Vitamin C (p=0,00; r=0,63) and Vitamin E (p=0,015; r=0,22) intake towards the lung function. There are differences in vitamin C and E intake, the lung function of a smoker and non-smoker; and the influence of Vitamin C and E intake on the lung function.

The correlation test in this study was conducted to look at the relationship between vitamins A, C, and E intake levels and lung function. A correlation test was performed with the Spearman test. The Spearman test was used because the two variables studied had an ordinal scale. We found that the significance value for the intake of vitamins A, C, and E was below

$>0.05$ , which means that  $H_0$  is accepted. For the relationship between vitamin A intake and lung function, the correlation value obtained was  $-0.036$ . It means that vitamin A and lung function have a deeply weak correlation and are inversely proportional. The relationship between vitamins C and E got a correlation value of  $0.000$ , meaning that the intake of vitamins C and E had no relationship or correlation. It is contrary to research conducted by Tsiligiani and Molen (2010), where vitamins A, C, and E are directly proportional to lung function.

The food intake patterns in the two groups were largely the same. The highest vitamin A in the two groups came from fried eggs. These foods are also high in vitamin E but do not contain vitamin C. Meanwhile, the most consumed food containing vitamin C in both groups was lodeh (Table 3). Most of the respondents experienced deficiencies in vitamins A, C, and E in both groups (Table 4). In this study, most of the respondents did not meet the adequate intake of vitamin A (76 of 79). These results indicate the source of vitamin A comes from the foodstuffs group, oil, animal side dishes, vegetables, and chili sauce. Vitamin A from this food was only seen in the content of the raw ingredients. But it has not been observed how much vitamin A is in these food dishes. The highest intake of vitamin A in this study came from cooking oil. It could be related to a government policy that launched a program that requires cooking oil to be fortified with vitamin A. Vitamin A contained in cooking oil will degrade during the frying process. The results showed that after the third frying will lose more than one-third of the vitamin A content. The frying method used by the Indonesian people is the usual method that allows cooking oil to be exposed to light and oxygen. In addition, repeated frying using the same oil is often done by the public (Martianto and Marliyati, 2009).

The strength of the relationship between vitamin A intake and % FEV1 and % FVC is in the very weak category. It was presumably because the vitamin A content of food ingredients is lost/damaged during processing. Most of the intake of vitamin A in this research comes from cooking oil absorbed in food ingredients. The oil absorption in fried food

ingredients ranges from  $10.73\%$  –  $23.02\%$ . The frying method used by the Indonesian people is a usual frying method that allows cooking oil to be exposed to light and oxygen. Besides, frying done repeatedly using the same oil is often done by the community. The results showed that after the third frying, more than a third of the vitamin A content was lost (Martianto and Marliyati, 2009). Vitamin A will be mobilized from the liver when it is needed by the body in the form of retinol transported by Retinol-Binding Protein (RBP) synthesized in the liver. Retinol uptake by various body cells depends on receptors on the membrane surface specified for RBP. Then it is transported through the cell membrane to bind to Cellular Retinol Binding-Protein (CRBP), and RBP is then released (Park et al., 2016). In smokers, there will generally be a decrease in appetite, causing malnutrition (Benowitz, 2009). This malnutrition condition will cause disruption in the formation of RBP, thought to be one of the causes of the weak effect of vitamin A intake on lung function.

The test for differences in vitamin C intake between the two groups showed no significant difference. The results of the meta-analysis conducted by Dallongeville et al. (1998) showed that active smokers are significantly higher in consuming energy, total fat, saturated fat, cholesterol, and alcohol and lower in consuming polyunsaturated fat, fiber, vitamin C, vitamin E, and beta carotene than nonsmokers. Smokers have the habit of eating sources of Vitamin C, namely fruits and vegetables which are significantly lower than smokers. Dietary changes associated with smoking are due to nicotine causing decreased appetite and decreased perception of taste and smell, which may make fruits and vegetables less appetizing (Komiyama et al., 2013).

Vitamin C is an antioxidant because it has an electron donor group in the form of an enediol group, located on the C2 and C3 atoms allowing vitamin C to be able to capture hydroxyl radicals. The electron donated by vitamin C can prevent the formation of other compounds from the oxidation process by releasing a one-carbon chain. But after giving electrons to free radicals, vitamin C will be oxidized to relatively stable semi dehydroascorbic acid or ascorbyl radical. This property may make it an antioxidant. In



other words, ascorbic acid can react with free radicals, and this reaction can reduce reactive free radicals to be unreactive. Free radicals that have been reduced from being reactive to being unreactive are called scavengers or sequencing (Park et al., 2016). The antioxidant properties of vitamin C can be attributed to its ability to neutralize free radicals caused by cigarette smoke in the lungs. Vitamin C is also thought to help repair lung tissue by synthesizing collagen and preventing free radical-induced lipid peroxidation, and restoring the level of vascular endothelial growth factors and alveolar cell proliferation in the lungs (Benowitz, 2009; Batra et al., 2016).

Vitamin E as an antioxidant works by stopping the free radical chain reaction. It donates one hydrogen atom from the 6-hydroxyl in the chroman ring, which can change the peroxy radical (the result of lipid peroxidation) into tocopherol. It is less reactive, so it will not damage the fatty acid chain. Tocopherol radicals can be regenerated by the presence of glutathione or vitamin C (Komiya et al., 2013). The highest sources of Vitamin E consumed in this study came from palm oil, eggs, and soybean tempeh. The weak relationship between vitamin E intake on lung function can also be suspected. Because when processing ingredients containing vitamin E are processed at high temperatures repeatedly. It will reduce the concentration of vitamin E content and change the form of fatty acids, thus reducing the antioxidant effects of vitamin E (Jaarin and Kamsiah, 2012; Yuniati and Almasyhuri, 2012; Leong et al., 2015). Vitamin E is a fat-soluble vitamin and works on the lipid phase of cells. Smokers generally experience weight loss caused by the hormone leptin, which limits fat reserves in the body. The low-fat reserves in the body are thought to inhibit vitamin E activity (Audrain-McGovern and Benowitz, 2011). The weak relationship between vitamin E intake and lung function may also be due to the respondents' low vitamin E intake, below the RDA, and other factors that can affect lung function. Namely physical exercise, levels of exposure to pollutants, stress, and genetics (Puente -Maestu and Stringer 2018). The weak correlation relationship may also cause by other nutrients from the food

that affect lung function but were not studied in this study, such as flavonoids. Previous research conducted by Garcia-Laersen et al. (2017) showed that individuals who consumed more anthocyanin-type flavonoids had lower FEV1 and FVC decreases than individuals who consumed fewer anthocyanins.

## Conclusion

There was no significant difference in the intake of antioxidants in the form of vitamins A (p-Value = 0.889), C (p-Value = 0.987), and E (p-Value = 0.987) in the food group with respiratory disorders and groups without respiratory problems. And there is no relationship or correlation between the intake of vitamin A (p-Value = 0.652), C (p-Value = 1,000), and E (p-value = 1,000) in food with lung function in the respiratory distress group and without interference.

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