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RESEARCH ARTICLE

Differences of Vital Lung Capacity and FEV_1/FVC Ratio on Children in Urban and Rural

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Abstract

Urban areas are places with high levels of air pollutant. This air pollution causes decreased lung function and obstruction in the respiratory tract. The absorption of dust particles and pollution is inhaled into the lungs through the respiratory mechanism. The entry of toxic material will react with the cells causing free radicals that will damage cells, especially in the respiratory system. This study was aimed to knowing the differences vital lung capacity and forced expiration volume in 1 second/forced vital capacity (FEV_1/FVC) ratio in children in urban areas with high level pollution and in rural areas not exposed to pollution. This study was an observational analytic study, implemented in September–December 2016 with a total sample of 70 children consisting of 35 children in Palembang city and 35 children in Musi Rawas area. Data analysis to determine the differences of lung vital capacity and FEV_1/FVC ratio in children in rural and urban with independent t test. The result showed that the average value of urban vital lung capacity in urban (1,205 mL) was lower than the mean value of vital lung capacity of children in rural (1,493 mL) and there was significant difference in the value of vital lung capacity in rural children and urban (p=0.004). The ratio of FEV_1/FVC for children in urban areas (91.05%) was lower than the ratio of FEV_1/FVC for children in rural (93.96%) as well as a significant difference in the ratio of FEV_1/FVC in rural and urban children (p=0.001). In conclusion, the mean value of lung vital capacity and the ratio of FEV_1/FVC of children in urban areas is lower than mean value of vital lung capacity of children in rural areas.

Keywords: FEV_1, FVC, spirometry, vital lung capacity

Perbedaan Kapasitas Vital Paru dan Rasio FEV_1/FVC pada Anak di Perkotaan dan Pedesaan

Abstrak

Perkotaan merupakan tempat dengan tingkat paparan polusi udara yang tinggi. Polusi udara ini menyebabkan penurunan fungsi paru-paru dan obstruksi pada saluran pernapasan. Absorpsi partikel debu dan polusi terhirup masuk paru-paru melalui mekanisme pernapasan. Masuknya bahan toksik ini akan bereaksi dengan sel sehingga menimbulkan radikal bebas yang akan merusak sel terutama pada sistem pernapasan. Tujuan penelitian ini adalah mengetahui perbedaan kapasitas vital paru dan rasio *forced expiration volume in 1 second/forced vital capacity* (FEV_1/FVC) pada anak di perkotaan dengan tingkat polusi yang cukup tinggi dibanding dengan pedesaan yang tidak terpapar polusi. Penelitian merupakan penelitian observasional analitik dilaksanakan pada bulan September–Desember 2016 dengan jumlah sampel 60 orang terdiri atas 30 orang anak di Kota Palembang dan 30 anak di daerah Musi Rawas. Analisis data untuk mengetahui perbedaan kapasitas vital paru dan rasio FEV_1/FVC pada anak di pedesaan dan perkotaan menggunakan uji T tidak berpasangan. Hasil penelitian didapatkan nilai rerata kapasitas vital paru anak di perkotaan (1.205 mL) lebih rendah daripada nilai rerata kapasitas vital paru anak di pedesaan (1.493 mL) dan didapatkan perbedaan bermakna nilai kapasitas vital paru antara anak di perkotaan dan pedesaan (p=0,004). Nilai rasio FEV_1/FVC anak di perkotaan (91,05%) lebih rendah daripada rasio FEV_1/FVC anak di pedesaan (93,96%) yang berbeda bermakna (p=0,001). Simpulan, nilai rerata kapasitas vital paru dan rasio FEV_1/FVC anak di daerah perkotaan lebih rendah daripada nilai rerata kapasitas vital paru anak di daerah pedesaan.

Kata kunci: FEV_1, FVC, kapasitas vital paru, spirometri

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Introduction

Many developing countries are faced with air pollution problems. Air pollution is an entry or mixing of harmful elements into the atmosphere so that it can lead to environmental damage that can reduce the quality of the environment. Air pollution is important study material because of the existence of chemical substances, biological materials, and particles that harm people, which humans can't avoid breathing or breathing air.[1]

In general, there are two sources of air pollution, ie pollution due to natural sources, such as volcanic eruptions, and those derived from human activities, such as those originating from transportation, plant emissions, forest burning, and others. In the world, there are six major types of air pollutants derived from human activities: carbon monoxide (CO), sulfur oxide (SOx), nitrogen oxide (NOx), particulates, hydrocarbons (HC), and photochemical oxides, including ozone. In Indonesia, approximately 70% of air pollution caused by motor vehicle emissions. Motor vehicles release hazardous substances that can have negative impacts, both on human health and on the environment, such as lead (Pb), nitrogen oxide (NOx), hydrocarbons (HC), carbon monoxide (CO), and photochemical oxides (Ox). Motor vehicles contribute nearly 100% of lead, 13–44% of suspended particulate matter (SPM), 71–89% of hydrocarbons, 34–73% NOx, and almost all carbon monoxide (CO). The main source of dust comes from burning household waste, which includes 41% of the dust source.[2]

Air pollution usually occurs in large industrial density cities as well as biomass burning areas that produce gases that contain substances above the limits of reasonableness. The narrowness of green land or trees in an area can also worsen the air quality in the place. More and more motor vehicles and industrial tools that emit gas that pollute the environment will get worse also air pollution that occurs.[3]

Air pollution contains ultrafine particles of combustion emissions, PAH compounds, carbon organic, inorganic elements (metal) and compounds contained in biomass burning ultrafine smoke particles such as benzo pyrene (BaP), CO, and Pb, when the compound enters the cell will produce radical compounds such as O_2 (superoxide radical), OH (hydroxyl radical) and H_2O_2 (hydrogen peroxide). These substances can react directly with extracellular and intercellular elements such as proteins, lipids, carbohydrates and DNA.[2]

Toxic materials in the form of organic gases and ultrafine particles can enter the alveolus of the lungs through the respiratory system and can enter into circulatory system and transferred to other organs. The entry of these toxic substances will react with the cells causing reactive oxygen species (ROS). When the radical compound reacts with the cell, it will cause lipid peroxidation, membrane protein damage and DNA damage. Lipid peroxidation results in a decrease in membrane fluidity in the membrane barrier function resulting in the destruction of even cell death.[4]

Ultrafine particles can cause respiratory effects, namely pulmonary inflammation, allergic response, and decreased lung function. Based on research by Masruroh et al.[5] the exposure of particles concentrated in the air in the short term, can induce the occurrence of rat inflammation of pulmo such as emphysema, defined as a widening of the alveoli, alveoli ducts and loss of the boundary membrane between of alveoli and alveoli ducts. The loss of the boundary between the alveoli and subsequent alveoli widening is due to cell death or cell apoptosis in the alveoli membrane.[5,6]

Pulmonary inflammation, allergic response, and pulmonary emphysema as a result of exposure to forest fire haze are expected to affect the results of lung spirometry examination. Exposure to air pollution will generally cause obstruction in the respiratory tract as indicated by a decrease in FEV_1/FVC ratio. Children are vulnerable ages to be affected by the effects of air pollution on health that can inhibit the growth and intellectual development of children.[7]

This study aims to determine differences in vital lung capacity and FEV_1/FVC ratios of urban children exposed to air pollution and rural children not exposed to air pollution.

Methods

This study was a comparative descriptive study to see differences in lung function in children in urban and rural. This research was conducted in September–December 2016 on two places, namely in one elementary school in the city of Palembang and in one of the primary schools in the area of Musi Rawas aren't exposed to air pollution. This research has received a certificate of ethics number: 07/X/2016 from Research Ethics

Committee, Unit of Bioethics, Humanities and Islamic Medicine (UBHKI), Faculty of Medicine, Universitas Muhammadiyah Palembang. The variables studied were pulmonary vital capacity and ratio of FEV_1/FVC in children in urban and rural areas.

Data analysis using primary data from the result of measurement directly both variable in two group of the sample by using spirometry tool. Procedure examination with the tool, steps as follows: sample asked to stand by inserting mouthpiece spirometry into the mouth and nose covered with nose clamp tool, then asked to breathe as for five times and ends with maximum inspiration and expiration maximally. The experiment was repeated three times, taking the highest value. After that, the data were analyzed by unpaired t test and presented in the tabular and narrative form.

Results

The study was conducted on elementary school children in urban and rural areas with a total samples of 70 people. Each group consisted of 35 samples who met inclusion criteria and didn't meet the exclusion criteria. Sampling was done by stratified random sampling technique in 4^{th}, 5^{th} and 6^{th} grade elementary school children.

The average result of vital capacity of lungs in urban children was 1,205 mL, smaller than the lung's vital capacity for rural children of 1,493 mL. After normality test data obtained all data was normally distributed. Then after data analysis using unpaired t test, got value $p=0.010$ ($p<0.05$) so it can be concluded that there was significant difference of vital capacity of lung in children in urban and in rural (Table).

The average FEV_1/FVC ratio for children in urban areas was 91.05%, greater than the ratio of FEV_1/FVC for rural children of 93.06%. After the normality test data obtained all data was normally distributed. Then after data analysis using unpaired t test, got value $p=0.030$ ($p<0.05$) so it can be concluded that there was significant difference of ratio of FEV_1/FVC between children in urban and in rural (Table).

Discussion

From the results obtained value of vital lung capacity in children in urban lower than children in rural areas. This is consistent with Sandra[8] research on the Indonesian human lung capacity survey which results in differences in vital pulmonary capacity for each different population.

Forced vital capacity (FVC) is defined as the volume of air exhaled with maximal effort from a maximum inspiration. Vital capacity is similar to the FVC. Many factors that affect a person's vital lung capacity include age, sex, physical activity, nutritional status, history of disease and environment. Urban environments have high smoke exposure that can affect lung function. In addition, low physical activity in children in urban areas causes vital lung capacity to be lower than children in rural areas.[9]

By performing regular physical activity, vital capacity of a person's lung increases. Theoretically, the muscles can contract maximally so that chest cavity widened, it causes the amount of O_2 entering the bloodstream in the lung increases as well as the increase of pulmonary blood flow. Thus total amount of O_2 entering the blood also increases during physical activity, otherwise amount of CO_2 released will also increase.[10]

From the results of this study, obtained the value of the ratio of FEV_1/FVC in children in urban lower than children in rural. This is consistent with the research of Barros et al.[11] explains that the ratio of FEV_1/FVC can detect the presence of airway obstruction in many individuals such

Table Vital Lung Capacity Value and Ratio Value FEV_1/FVC

	Mean (mL)	Standard Deviation	p'	p"
Vital lung capacity				
Urban	1,205	0.63800	0.8979	0.010
Rural	1,493	0.36028	0.9764	
Rasio FEV_1/FVC				
Urban	91.05	4.47372	0.7885	0.030
Rural	93.96	7.29595	0.8790	

p': test data normality, p": unpaired t test as the ratio of FEV_1/SVC so reliable to detect the presence of later lung obstructive disease. Sandra9 study also obtained traffic police staf who had restriction lung function status of 8 people (38.1%) more than police staf had restriction lung function status of 2 people (9.5%). This is in line with the decline in air quality characterized by high levels of NO_2, SO_2 and dust from air pollution and motor vehicle fumes.

Pollution from vehicle fumes contains ultrafine particles that have a very small size (≤0.1 µm) that can be inhaled up to alveoli. Ultrafine particles (UFPs) cause the muccociliary and alveolar clearance functions to be exceeded, allowing the ultrafine particles to persist in the alveolus and causing immediate reaction with epithelial cells and causing cell damage to alveoli. UFP can cause effects on the respiratory system, namely increased pneumonia, allergic response, and decreased lung function. The exposure of particles concentrated in the air in the short term, may induce lung inflammation such as emphysema, defined as a widening of the alveoli, alveoli ducts and loss of the boundary membrane between alveoli and alveoli ducts. The loss of the boundary between alveoli and subsequent alveoli widening is due to cell death or cell apoptosis in the alveoli membrane. While the destruction of the alveolar septum is a damage to alveolar membrane which occurs damage to elastin protein and collagen epithelial membrane. Exposure to urban air pollution in general will cause obstruction in the respiratory tract as indicated by a decrease in the ratio of FEV_1/FVC.[4–6]

Trissekti et al.[12] research about the average FEV_1 value of basement parking attendant is greater than the average FEV_1 value of open space parking practitioners, because basement parking has a good exhaust fan working system so as to minimize the pollution caused by motor vehicle fume effectively and quickly so that not cause respiratory tract disturbance.

Conclusion

The mean value of lung vital capacity and the ratio of FEV_1/FVC of children in urban areas is lower than mean value of vital lung capacity of children in rural areas.

Conflict of Interest

The authors declare that they have no conflict of interest.

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