RESEARCH ARTICLE

pISSN: 0126-074X | eISSN: 2338-6223
https://doi.org/10.15395/mkb.v55n2.2169
Majalah Kedokteran Bandung. 2023;55(2):65–69

Majalah Kedokteran Bandung (MKB)

Received: October 15, 2020
Accepted: March 10, 2023
Available online: June 30, 2023

Relationship between Age, Exercise Habits, Cigarette Smoke Duration Exposure, and Lung Vital Capacity in Passive Smokers

Saskia Oktaviani Puteri,[1] Ratnawati Ratnawati,[2] Nura Eky Vikawati[3]
[1]Faculty of Medicine, Sultan Agung Islamic University, Indonesia
[2]Department of Public Health, Faculty of Medicine, Sultan Agung Islamic University, Indonesia
[3]Department of Physiology, Faculty of Medicine, Sultan Agung Islamic University, Indonesia

Abstract

Lung vital capacity of is different for each individual depending on personal characteristics, such as age, body mass index (BMI), and exercise habits or environmental factors, such as exposure to cigarette smoke. This study aimed to determine the relationship between personal characteristics, duration of exposure to cigarette smoke, and lung vital capacity in passive smokers in one of the areas in Indonesia. This study was a cross-sectional observational analytic study conducted during the period of August to September 2019. Data were collected through interviews and measurements using the Contec SP10BT spirometer. Participants were sampled consecutively with only women who did not smoke but had at least one family member who actively smoked and was over 20 years old participated in this study. Women were selected as the population due to the fact that the proportion of passive smokers among women is higher than men, while the age group of above 20 years old was selected with a consideration of the average age for the optimum lung capacity. The relationship between personal characteristics and a history of exposure to cigarette smoke with lung vital capacity was analyzed using Pearson and Spearman correlation test. There is a significant relationship between age, exercise habits, duration of exposure to cigarette smoke, and vital lung capacity (p=0.000; p=0.018; p=0.000) among the participants of the study. However, further research is still needed to be able to generalize this finding into a broader community.

Keywords: Lung vital capacity, passive smokers, personal characteristics

Introduction

Lung vital capacity is the maximum volume of air that can be released after maximum inspiration in one breath.[1] The large volume and capacity of lung function can be one indication of pulmonary abnormalities or disorders, both obstructive and restrictive.[2] Spirometry is the basic lung function test with different measurements. One of these is vital capacity, the highest level of air volume a device can exhale or inspire during a forced vital capacity (FVC) or a slow vital capacity (VC) maneuver. Some studies have found that FVC is smaller than VC in asthma and COPD patients due to airflow limitation, small airway collapse, and gas trapping.[3] Lung vital capacity can be affected by various things, including exposure to cigarette smoke and personal characteristics. Some things that must be considered in assessing the lung's vital capacity include age, exercise habits, and nutritional status.[4]

As a person ages, the lungs' vital capacity will decrease.[5,6] Instead, the lungs' vital capacity will increase with higher exercise frequency.[7] Exercise can increase blood flow through the lung, causing oxygen to diffuse into the pulmonary capillaries at a greater volume. This is proved by the vital lung capacity of an athlete greater than those who have never exercised.[8] In obesity, compliance of the chest wall and abdomen decreases, resulting in an increased work of breathing, and a decrease in residual volume and vital lung capacity.[9,10]

The reduced lung function can also be affected by exposure to cigarette smoke. Previous studies stated a positive relationship between passive smokers and respiratory symptoms with lung vital capacity.[11] Irritation of the airways by cigarette smoke and other toxic substances would cause an inflammatory reaction, resulting in deposits of neutrophils and macrophages

Corresponding Author:
Ratnawati
Department of Public Health, Faculty of Medicine, Sultan Agung Islamic University, Indonesia
Email: ratnawati@unissula.ac.id

in these areas.[12] Passive smokers were more common in women than men.[13]

The Indonesian government has tried to reduce the number of passive smokers by issuing Law No. 36 of 2009 concerning Health in Article 115, about No Smoking Area (KTR). However, there are still no studies about the relationship between personal characteristics and exposure to cigarette smoke with lung vital capacity in the same region. Hence, this study aimed to know the relationship between personal characteristics and duration of exposure to cigarette smoke with lung vital capacity in passive smokers in RW 3 Penggaron Lor Semarang.

Methods

This was an observational study conducted in October 2019 at RW 3 Penggaron Lor, Semarang. Penggaron Lor was chosen because it is a fostered village of the Faculty of Medicine of Sultan Agung Islamic University, and RW 3 was chosen based on the location of previous research. The total population in there is about 3,200 people. The subject of this study were all residents of RW 3 Penggaron Lor Semarang who have at least one family member of an active smoker and live in one house. All samples were over 20 years old and had no complaints of pulmonary disease, such as shortness of breath and coughing. The exclusion criteria included having complaints of pulmonary diseases, such as shortness of breath and cough, a history of drug use, primarily asthma reliever or controller drugs, having an anatomical disorder, and the subject refused to participate. The minimum sample size is calculated using the formula below:

$$N = \left[\frac{Z\alpha + Z\beta}{0{,}5\mathrm{In}\left[\frac{1+r}{1-r}\right]}\right]^2 + 3 = \left[\frac{1{,}96 + 0{,}842}{0{,}5\mathrm{In}\left[\frac{1+0{,}39}{1-0{,}39}\right]}\right]^2 + 3 = 50$$

If the degree of relationship in previous research is the correlation coefficient= 0,39 (Fakhrullah,2016) α:0.05 (p=0.05), Zα: 1.96; (research power 80%) Zβ: 0.842, then the minimum sample size is 50 respondents. If there is a drop-out of 10%, the minimum sample size with drop-out correction is:

$$n=10\%\times N=10\%\times 50=5$$

Based on these calculations, the sample size in this study was 55 respondents. Sampling was done by consecutive sampling, by visiting people's homes, where all subjects who met the inclusion criteria were included in the study until the required number of subjects was met.

The age range of this study was 22–65 years old, with the median age being 43 years old. The BMI variable was measured using the formula:

The results are expressed in units of kg/m^2 based on Riskesdas 2013, were grouped as follows:[14]

$$\textbf{BMI} = \frac{\text{Weight } (kg)}{\text{Height } (m)^2}$$

In this study, the BMI was grouped into three groups, thin, normal, and obese, where the criteria for overweight and obesity on *Riskesdas* 2013 were included in one criterion. The weight was measured using a body scale, and a microtome measured the height. However, only participants who forgot their weight and height were measured due to inadequate space. The exercise habit variable was measured through direct interviews, including the one-week exercise frequency. The results are expressed in units of times/week, divided into three groups, 0 times per week, one time per week, and two times per week.

Length of exposure to cigarette smoke is the length of time the respondent is exposed to cigarette smoke in years. Variables were measured through direct interviews. The results are expressed in years. We did not use the Brinkman index because we focused on passive smokers, not active smokers. The lung vital capacity assessed in this study is the forced vital capacity (FVC), the maximum air that can be exhaled when blowing out as fast as possible.

FVC measurement is done by inhaling as deeply as possible, then exhaling quickly and forcefully. The results are expressed in percentage units and classified according to the degree of severity. The classification of FVC's degree can see in the following table:

Data on age, exercise habits, and duration of cigarette smoke exposure were obtained through direct interviews, while IMT data were obtained

Table 1 Body Mass Index Classification

	BMI*
Thin	≤18.5
Normal	18.5–25
Overweight	25.00–<27.0
Obesity	≥27

*Body mass index

Table 2 Degrees of Forced Vital Lung Capacity[15]

Degree	%pred FVC*
Normal	≥80
Mild	70–79
Moderate	60–69
Moderate-Severe	50–59
Severe	35–49
Very severe	<35

*forced vital capacity

through weight measurements using portable scales and height using microtoice. FVC values were obtained through measurements using the Contec SP10BT spirometer.

Data normality was tested with the Kolmogorov-Smirnov test, and data correlation was tested with the Pearson dan Spearman test. The normality test results on the independent variables obtained showed that age and duration of exposure to cigarette smoke were normally distributed, so both variables used the Mean value. While the variables of nutritional status and exercise habits are not normally distributed, so the two variables use the median value. This study has received Ethical Clearance from the Faculty of Medicine, Sultan Agung Islamic University with No. 716/X/2019/Bioethics Commission.

Results

Personal characteristics are independent variables of this study that consist of age, BMI, exercise habits, and the duration of cigarette smoke exposure. The personal characteristics and the duration of cigarette smoke exposure can see in Table 3.

From Table 3, it can be seen that the majority of the subjects of this study have a normal BMI, average age of 42.76 years, 78% of the people never exercised in one week, and were exposed to cigarette smoke for 19.38 years.

Lung vital capacity is a dependent variable in this study that is measured by forced vital capacity (FVC) value. All the subjects of this study had a mean FVC of 71.63% and were categorized as a mild degree. The normality test results based on Kolmogorov-Smirnov show that the FVC variable is normally distributed. The analysis of the relationship between personal characteristics and the duration of cigarette smoke exposure with lung vital capacity can see in Table 4.

Discussion

This study showed a relationship between age and lung vital capacity. A previous study conducted by Bintang et al. in 2017 found a negative correlation between age and vital

Table 3 Description of Personal Characteristics of All Subjects in RW 3 Penggaron Lor Semarang

Personal Characteristics Variable	n	Mean	SD*	Median	Min	Max
Age (years)	55	42.76	10.89			
The duration of cigarette smoke exposure (years)	55	19.38	11.00			
BMI** ($kg/m^{2)}$	55			23.20	17.3	35.4
Underweight	3 (5%)					
Normal weight	28 (51%)					
Overweight	24 (44%)					
Exercise Habits (times per week)	55			0	0	2
0 times per week	43 (78%)					
1 times per week	9 (17%)					
2 times per week	3 (5%)					

*standard deviation;** body mass index

Table 4 Relationship between Personal Characteristics and the Duration of Cigarette Smoke Exposure with Lung Vital Capacity in RW 3 Penggaron Lor Semarang

Variable	n	Mean	Median	Min	Max	p	r
Age	55	42.76	49	22	65	0.000	-0.496**
BMI	55	24.27	23.20	17.3	35.4	0.501	-0.093*
Exercise Habits	55	0.57	0	0	2	0.018	0.317*
The duration of cigarette smoke exposure	55	19.38	20	2	40	0.000	-0.563**

* Spearman's Rank Correlation Test; ** Pearson Product Moment Correlation Test

capacity, which means that vital capacity will decrease as age increases.[16] Another study in 2012 conducted on 30 parking attendants in Jalan Pandanaran, Semarang, stated there was a relationship between age and lung function of parking attendants who were generally healthy. This is in line with the theory, which states that as a person ages, organ function will decrease. [17] This study's results of BMI values showed no relationship between BMI and lung vital capacity. A cross-sectional study involving 2,617 students in all universities in China in 2015 found that body mass index was not related to vital capacity.[18] A meta-analysis conducted in 2018 stated that obesity will reduce a person's vital lung capacity.[19] The meta-analysis used the term "obesity," did not involve subjects with underweight nutritional status, and included children as subjects. This differs from this study because this study uses the term "fat," which involves subjects with underweight nutritional status and does not involve children.

This study showed a relationship between exercise habits and lung vital capacity. An experimental study involving female students in Iran in 2016 found that sports-type performance training would increase vital capacity.[20] Other studies in India have also shown similar results, that regular exercise will affect the vital capacity of the lungs, especially FVC value. This is due to the higher level of someone's physical activity and the higher level of fitness, too, especially in cardio-respiratory.[21]

The results of this study indicate a relationship between exposure to cigarette smoke with lung vital capacity. A cross-sectional study 2017 at the Faculty of Medicine James, University of Anguilla, Caribbean, found that active smokers, passive smokers, and ex-smokers will have lower lung vital capacity than people who are rarely or have never been exposed to cigarette smoke. This is because chronic exposure to cigarette smoke can lead to respiratory diseases such as chronic obstructive pulmonary disease (COPD), emphysema, chronic bronchitis, and lung cancer, thereby reducing the lung vital capacity.[22] This study showed that besides age, BMI, and exercise habits, exposure to cigarette smoke also affects lung capacity, which could impact the quality of life.

The limitation of this study is that other factors not analyzed in this study can affect lung vital capacity, such as work and exposure to dust or vehicle fumes. Data on the length of exposure to cigarette smoke studied in this study only smoked cigarettes from the home environment. At the same time, respondents could be exposed to cigarette smoke on the streets and at work. In conclusion, a significant relationship exists between age, exercise habits, and duration of exposure to cigarette smoke with lung vital capacity. Besides that, this study shows that smoking impacts smokers and the people around them.

References

1. Sherwood L. Introduction to human physiology. 8th ed. Jakarta: EGC; 2013.
2. Guyton AC, Hall JE. Guyton and hall textbook of medical physiology. 12th ed. Jakarta: Elsevier; 2011.
3. Yuan W, He X, Xu QF, Wang HY, Casaburi R. Increased difference between slow and forced vital capacity is associated with reduced exercise tolerance in copd patients. BMC Pulm Med. 2014;7:14–6.
4. Sirait M. Hubungan karakteristik pekerja dengan faal paru di Kilang Padi Kecamatan Porsea tahun 2010. Medan: Fakultas Kesehatan Masyarakat Universitas Sumatra Utara; 2010.
5. Badri H, Syahputra R., Pudia M. Relationship

of age on lung vital capacity. Advances in Health Sciences Research. 2021;35:226–7.
6. Talaminos BA, Marquez ME, Roa RLM., Ortega RF. Factors affecting lung function: a review of the literature. Archivos de Bronconeumología (English Edition); 2018;54(6):327–32.
7. Awad KM, Magzoub A, Elbedri O, Musa O. Effect of physical training on lung function and respiratory muscles strength in policewomen trainees. Int J Research Medical Sci. 2017;5(6):2516.
8. Kholifah N. Perbandingan tingkat kapasitats vital paru siswa yang mengikuti ekstrakurikuler bulutangkis dan ekstrakurikuer bola voli di SMA Negeri 1 Sedayu. Yogyakarta: Ilmu Keolahragaan Universitas Negeri Yogyakarta; 2016.
9. Dixon AE, Peters U. The effect of obesity on lung function. Expert Rev Respir Med. 2018;12(9):755–67.
10. Mafort TT, Rufino R, Costa CH, Lopes AJ. Obesity: systemic and pulmonary complications, biochemical abnormalities, and impairment of lung function. Multidiscip Respir Med. 2016;11:28.
11. Nurjanah. Efek paparan second hand smoke terhadap fungsi paru karyawan Universitas Dian Nuswantoro Semarang. J Visikes. 2013;12(1):16–26.
12. Haris A, Ikhsan M, Rogayah R. Asap rokok sebagai bahan pencemar dalam ruangan. Jakarta: Departemen Pulmonologi dan Ilmu Kedokteran Respirasi, Fakultas Kedokteran Universitas Indonesia-RS Persahabatan. Available from: https://repository.uinjkt.ac.id/dspace/handle/123456789/44041.
13. Salimzadeh H, Najafipour H, Mirzaiepour F, Navadeh S, Shadkam-Farrokhi M, Mirzazadeh A. Prevalence of active and passive smoking among adult population: findings of a population-based survey in Kerman (KERCADRS). Addict Health; 2016;8(1):16–24.
14. Riset Kesehatan Dasar. Jakarta: Badan Penelitian dan Pengembangan Kesehatan Departemen Kesehatan Republik Indonesia; 2013.
15. Haynes, J. Basic spirometry testing and interpretation for the primary care provider. Canadian J Respiratory Ther. 2018;54:92–8.
16. Bintang S, Yuli K. Hubungan usia, lama paparan debu, penggunaan APD, dan kebiasaan merokok dengan gangguan fungsi paru tenaga kerja mebel di Kecamatan Kalijambe Sragen. J Kesehatan; 2017;10(2):37–46.
17. Putra DP, Rahmatullah P, Novitasari A. Hubungan usia, lama kerja, dan kebiasaan merokok dengan fungsi paru pada juru parkir di Jalan Pandanaran Semarang. J Kedok Muhammadiyah. 2012;1(3):7–12.
18. Sun X, Chen X. The relationship between obesity and forced vital capacity among university students. Nutr Hospitalaria. 2015;31(5):2202–4.
19. Forno E, Han YY, Mullen J, Celedón JC. Overweight, obesity, and lung function in children and adults-a meta-analysis. J Allergy Clin Immunol Pract. 2018;6(2):570–81.e10.
20. Azhang M, Khayyam BK, Fazel AA, Bagheri L, Emamdoost S, Otadi K. Comparison effect of conventional corrective exercise and physioball exercise on improvement of hyperkyphosis and vital capacity in female students. J Modern Rehabilitation. 2016;9(6):168–76.
21. Sabaananth S, Gopinath V, Thevanthy T. Effect of different dance training on vital capacity among post-pubescent girls. Int J Multidisciplinary Studies; 2014;1(1):85–9.
22. Hammoudi D, Sanyaolu A, Adofo D, Antoine I. The effect of cigarette smoking on lung capacity in active, previous, and passive student smokers. GMJ Med. 2017;1(1):3–8.