Asian Journal of Scientific Research

ISSN 1992-1454

science alert
http://www.scialert.net

ANSInet
an open access publisher
http://ansinet.com

OPEN ACCESS Asian Journal of Scientific Research

ISSN 1992-1454
DOI: 10.3923/ajsr.2020.175.180

Research Article
Evaluation of Pulmonary Function Status of the Construction Site's Workers

Nur Nabilah Mohamad Sulaiman, Normah Awang, Nurul Farahana Kamaludin, Mohd Riduan Abdullah and Shamrul Aizam Abdul Rahman

Environmental Health and Industrial Safety Programme, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia

Abstract

Background and Objective: Workers at construction site are always exposed to high concentration of dusts at their workplace. There are many sources of dusts at construction sites including concrete, silica, asbestos, cement, wood, stone and sand materials used in construction work. Dusts particles inhaled will remain in the lungs and cause irritation to the lungs, as well as excessive mucus secretion, which promotes poor lung function, pneumonia, chronic obstructive pulmonary disease and restrictive lung disease. Thus, the main objective of this study was to study the lung function of the construction site's workers. **Materials and Methods:** A total of 80 individuals were selected, comprising of 40 construction site workers and 40 office workers. Lung function tests were performed using Pony FX spirometer to detect any changes in lung function parameters. Forced vital capacity (FVC), forced expiratory volume in one second (FEV1) and the percentage of FEV1 to FVC (FEV1 /FVC) were all assessed using the spirometer. **Results:** The performance of the lung function test on workers at construction site was poorer compared to those of the office workers. Based on Independent t-test using IBM SPSS Statistics 21, there were significance differences ($p<.05$) in FEV1 and FVC between both groups. **Conclusion:** In conclusion, this study found that exposure to high concentration of dusts may be one of the factors that reduce the lung function among construction workers.

Key words: Lung function, construction workers, spirometry test, lung disease, lung disease, spirometer

Citation: Nur Nabilah Mohamad Sulaiman, Normah Awang, Nurul Farahana Kamaludin, Mohd Riduan Abdullah and Shamrul Aizam Abdul Rahman, 2020. Evaluation of pulmonary function status of the construction site's workers. Asian J. Sci. Res., 13: 175-180.

Corresponding Author: Normah Awang, Environmental Health and Industrial Safety Programme, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Lung is an important organ involved in gaseous exchange. It allows absorption of oxygen and expulsion of carbon dioxide during respiration. Several factors that can contribute to poor lung functions are diseases, allergies and infections[1]. Working environment is also an important factor that can affect respiratory health among workers[2]. A dusty working environment for instance can increase the risk of inhaling particles that may adversely affect a worker's respiratory system[3].

Construction activities generate high concentration of dusts and this can lead to significant respiratory dysfunctions among construction workers[4]. Poor lung function is the most common respiratory illness reported among workers exposed to harmful dust particles[5]. Main sources of dusts generated at all construction sites include concrete, silica, asbestos, cement, wood, stone, sand[1,3,6]. Increased specialization and the use of power handheld tools at construction work both could increase workers' exposure to dusts over the complete workdays[5,7].

Cumulative exposure to respirable dusts in several construction task groups have been reported by Bakke *et al.*[8]. Construction workers also has been reported to experience the respiratory problems and related with changes in chest radiographs and pulmonary function[9]. These spirometric parameters allow us to distinguish between obstructive and restrictive lung status in adults[10]. There is a limited number of studies focusing on the lung function status of the construction workers. This study was conducted to investigate the pulmonary function in construction workers in order to extend research on the respiratory health status of the construction workers. This study is important given that construction industry is growing rapidly in every developing country. The results of this study can be guidance for the employers in taking preventive measures that maintain the health of their workers.

MATERIALS AND METHODs

Study design, study population: A walk through survey was conducted to obtain information such as the number of workers, task involved, personal protective equipment and worker's exposure. This cross-sectional study was conducted at one of the construction sites at Shah Alam, Selangor, Malaysia, to test the lung function of the construction site workers. The lung function test was done from February 2019 until April 2019. There were 2 group of workers involved consisting of the exposed and non-exposed group of workers. According to the statistical calculations related to pulmonary function at construction site from a previous study by using G-Power version 3.1 software, a total number of sample size required is 80 individuals and selected randomly; comprising of 40 from the exposed group and 40 from non-exposed group. Exposed group consisted of workers at construction site while non-exposed group consisted of workers at the administration office. Exposed group is defined as the workers at construction site that exposed directly to dust during the whole working period everyday while non-exposed group is the workers without active exposure to dust at the construction site. These individuals worked for at least 6-8 h/day for 6 days a week.

Only male workers from exposed group and non-exposed group were included in this study. Conversely, workers that had asthma (before start working), had any heart related disease, had undergone chest/abdominal surgery in last 3 months, had experienced stroke or heart attack in the last 3 months or presented with a history of coughing up blood in last month were all excluded from this study.

Questionnaire: A validated St. George's Respiratory Questionnaire (SGRQ) was used to obtain information on participant's demography and respiratory disease. Each questionnaire consisted of 3 parts including sociodemographic data, history of respiratory diseases and occupational and work environment.

Spirometry test: Lung function tests was performed using Cosmed Pony FX spirometer (Rome, Italy) by measuring amount of air that we inhale and exhale and how quickly we exhale according to standard guideline of American Thoracic Society (ATS) protocols[11]. Parameters such as forced vital capacity (FVC), forced expiratory volume in one sec (FEV1) and the percentage of FEV1 to FVC (FEV1/FVC) were all assessed using spirometer.

Before performing spirometry, the equipment has been calibrated at the beginning of the session. Each test was conducted with a prior briefing on lung function tests to all the respondents in advance. Instruction and demonstration were given to the subjects. Lung function tests were conducted after collection of a detailed history and anthropometric data (height, weight and age). Spirometry was performed while the workers were in a seated position. There should be no difference in the amount of air the respondents can exhale for a sitting position compared to a standing position as long as they are sitting up straight and there are no restrictions. Respondents were asked to repeat the test 3 times after adequate rest to obtain the best measurement as recommended by the ATS.

First, they were instructed to take tidal (normal) breaths then inhaled to maximum capacity (total lung capacity). The nose clips were applied and they were then instructed to exhale as fast and as long as possible (to residual volume) until there is no air left. This was done through a mouthpiece into the spirometer to get the required parameters. The spirometry data were used to generate age, gender and race/ethnicity specific prediction equations for the normal spirometric values. These reference standards have been used widely in the research that associating to occupational pulmonary disease, the effects of air quality on spirometric function and also the relationship of smoking and COPD. The operations are based on the current standards for pulmonary function, equipment, testing and interpretation set by the American Thoracic Society (ATS). There are 3 basic patterns to recognize which are normal (FEV1 and FVC above 80% predicted and FEV1/FVC ratio above 0.7), obstructive (FEV1 below 80% predicted, FVC can be normal or reduced - usually to a lesser degree than FEV1 and FEV1/FVC ratio below 0.7) and restrictive (FEV1 normal or mildly reduced, FVC below 80% predicted and FEV1/FVC ratio normal-above 0.7).

Statistical analysis: Descriptive statistics were used to present the distributions of questionnaire data and lung function parameters. Independent t-test was used to compare the lung function parameters between the exposed and non-exposed group, with level of statistical significance set at $p<0.05$ for all comparisons. SPSS statistical software for Windows (Version 21.0; IBM Corp.; Armonk, NY, USA) was used as the analysis tool.

Ethical consideration: This study was approved by Universiti Kebangsaan Malaysia Research Ethics Committee in February 2019 (Approval No.: JEP-2019-052).

RESULTS

Sociodemographic data: All respondents involved in this study were given a consent form to know their willingness and voluntary. There was a 100% response rate from the workers that have been selected in this study. Table 1 shows the sociodemographic data of the workers included in this study. The mean age of workers at the construction site and administration office was 34.33 years old and 32.50 years old respectively. Mean weight and height of construction workers were 65.59 kg and 164.79 cm respectively while for their comparative group weighed 70.65 kg and had a mean height of 167.28 cm.

Contributing factors: The age, height, weight and smoking habit are the factors that contribute to respiratory health effects. Based on independent t-test (Table 2) to compare between exposed group and non-exposed group of workers shows that there was no significant difference of age, weight and height and period of working for both group with p value more than 0.05. The mean answer for the smoking status of exposed group (1.86±0.35) was higher than Non-exposed group (1.54±0.51) of the workers. However, there was also no significant difference of the smoking habits between both groups ($\chi^2 = 6.67$, $p = 0.10$).

Lung function test: Lung function test was conducted on all the respondents. Table 3 shows a significant difference in FVC% and FEV1% between construction site workers and administration workers ($p<0.01$). Nonetheless, no significant difference was observed for FEV1/FVC% between the two groups based on independent t-test. There was however a significant difference in abnormalities found among the construction workers and administration workers. The mean for all the parameters (FEV1, FVC and FEV1/FVC) were lower in the exposed group compared to non-exposed group.

The normality of the lung function between both groups is shown in Table 4. The pulmonary status was described as restrictive or obstructive and the spirometric results were interpreted according to the American Thoracic Society (ATS) guidelines. The abnormalities recorded in construction site workers which consists of restrictive and obstructive lung function (80%) were higher as compared to the administration workers (40%).

Table 1: Sociodemographic data of exposed and non-exposed group (n = 80)

	Groups	
Variables	Exposed (n = 40)	Non-exposed (n = 40)
Age	034.33	032.50
Height	164.79	167.28
Weight	065.59	070.65

Table 2: Contributing factors of the lung function

Factors	Exposed (Mean±SD)	Non-exposed (Mean±SD)	p-value
Age	034.33±8.70	032.50±10.96	0.412
Height	164.79±4.81	167.28±09.50	0.144
Weight	066.59±9.20	070.65±18.05	0.209
Working years	004.38±2.70	004.88±03.60	0.048
Smoking	001.86±0.35	001.54±00.51	0.010

Table 3: Spirometric parameters

Parameters	Exposed (Mean±SD)	Non-exposed (Mean±SD)	p-value
FVC	71.10±12.36	083.35±14.36	<0.01
FEV1	69.90±12.75	084.60±13.43	<0.01
FEV1/FVC	96.10±11.63	100.05±09.50	>0.01

FVC: Forced vital capacity, FEV: Forced expiratory volume, SD: Standard deviation

Table 4: Normality of lung function

	Exposed		Non- exposed		Total	
Diagnosed	Number	Percentage	Number	Percentage	Number	Percentage
Restrictive	29	72.5	14	35	43	53.7
Obstructive	3	07.5	2	5	5	06.3
Normal	8	20	24	60	32	40
Total	40	100	40	100	80	100

Table 5: Spirometric parameters of smokers and non-smokers

Parameters	Smokers (Mean±SD)	Non-smokers (Mean±SD)	p-value
FVC	76.35±15.04	79.85±13.53	0.34
FEV1	76.12±15.06	80.65±14.54	0.24
FEV1/FVC	97.45±10.18	100.85±10.54	0.22

FVC: Forced vital capacity, FEV: Forced expiratory volume, SD: Standard deviation

There were significantly lower FVC% and FEV1% among construction site workers compared to the administration office workers ($p<0.05$). This study demonstrated that about 80% of the exposed group developed abnormalities in lung function compared to only 40% from administration workers. This reduction in lung function mostly occurred among construction workers compared to the administration workers.

Lung function of the smokers: However, findings from this study showed no significant difference in lung function between smokers and non-smokers at the construction site as shown in Table 5. Despite the absence of a statistical significance, the readings for lung function were lower in the smokers than the non-smokers.

DISCUSSION

Age, weight, height and smoking status are strongly influence the lung function and airway inflammation according to American Thoracic Society[12]. The age, height and weight for the exposed workers and administration workers were not significantly different, thus these factors were successfully controlled. Besides, the smoking status and the working years between those study groups also showed no significant difference. A number of previous studies has suggested to control the smoking status and working period of the respondents. This is because smoking and working period might worsen the adverse effect of dust on the workers' lung function[13].

There were significantly lower FVC and FEV1% among construction site workers compared to the administration office workers ($p<0.01$). Based on previous study, the ventilatory functions (FVC, FEV1%) were significantly lower in construction workers compared to their respective control group[9]. The results from the a study has found that the ventilator indices of FVC, FEV1 and FEV1/FVC had significantly lower compared to control group which 35.7% of the exposed workers diagnosed with the abnormality in lung function compared to only 5.7% of the unexposed group[14]. The abnormalities in the lungs were indicated by FVC% and FEV1% collectively. Restrictive disorders occur when FVC% and FEV1% is reduced to <80% and the FEV1/FVC% ratio is normal at >70%. Conversely, obstructive disorder occur when FEV1% is reduced to less than 80% and FVC% usually reduced to less than 80% but not lesser than FEV1 %, whilst reducing the FEV1 /FVC% ratio to <70%[15-17].

This study demonstrated that about 80% of the exposed group developed abnormalities in lung function compared to only 40% from administration workers. This reduction in lung function mostly occurred among construction workers compared to the administration workers. The workers in both group showed higher in restrictive than obstructive may be influenced by the period of working (years) of the workers. Some of the workers had work for more than 5 years and more than 10 years which can increase the risk of respiratory health problem. However, the exposure for more than 10 years to cement dust conspicuously reduced the pulmonary function[18]. Some past studies demonstrated that the exposure to cement dust particles alone could lead to obstructive lung diseases[15,19]. A study of respiratory health among cement workers found that abnormalities of lung function among manufacturing workers was higher from administration workers[20]. Construction workers thus have a higher tendency to experience a decrease in lung function volume due to their direct exposure to dust particle while working compared to the administration workers. The reduction in lung function may possibly be associated with the exposure based on their work activities[16,19,21,22].

FVC and FEV1%, were not significantly difference between smokers and non-smokers among construction and administration workers. This shows that smoking status did not increase the risk of respiratory health problem in this study. Smoking is one of the factors that contribute to respiratory illnesses[11,23,24]. Smoking contributes to a high prevalence of respiratory health problem worldwide[23].

It is important to control the smoking status of the respondents as suggested by a number of previous studies by Tantisuwat and Thaveeratitham[23], Nordby *et al.*[25] and Isabel *et al.*[26]. Smokers had a higher risk of presenting with reduced lung function[27]. Based on American Thoracic Society, the lung function and airway inflammation are also influenced by smoking[23,28,29].

CONCLUSION

The dysfunction of lungs usually depends on direct or indirect exposure of dust particles. However, other factors also need to consider such as physical activities, sociodemographic factors and also the level of awareness and knowledge. Those factors may or may not affect the respiratory health status. Dust particles at construction site contain variety of pollutants, eventually the direct impact on respiratory disease causes by specific-related pollutant was not assessed in this study. Since the workplace exposure increased the risk of respiratory disease, the workers that exposed to dust for whole working hours may experience the lung function reduction. Overall, this study found that directly exposure to high concentration of dusts at construction sites may reduce lung function parameters among workers. Construction site workers should therefore undergo pulmonary function tests regularly to detect any changes and seek early treatment interventions.

SIGNIFICANT STATEMENT

This study discover the lung function of the workers at the construction site decrease may be due to the exposure to the dust that can be beneficial for the management to take further action to reduce the risk. This study will help the researcher to uncover the critical area of respiratory health status of the workers that many researchers were not able to explore.

ACKNOWLEDGMENT

We would like to thank Universiti Kebangsaan Malaysia by funding this study by GUP-2018-062 grant. We also like to thank all the workers who took part in this study and technical support from the laboratory assistant of Environmental Health and Industrial Safety Programme for all the help the provided during this study.

REFERENCES

1. Shobha, K.L., S. Venkatachalam, S. Nair, B. Elangu and P. Samuganathan *et al.*, 2017. Study of lung function on construction workers. Int. J. Health, 5: 97-99.
2. Healy, C.B., M.A. Coggins, M. van Tongeren, L. MacCalman and P. McGowan, 2014. Determinants of respirable crystalline silica exposure among stoneworkers involved in stone restoration work. Ann. Occup. Hyg., 58: 6-18.
3. Johncy, S.S., K.T. Ajay, G. Dhanyakumar, N.P. Raj and T.V. Samuel, 2011. Dust exposure and lung function impairment in construction workers. J. Physiol. Biomed. Sci., 24: 9-13.
4. Yassin, A., F. Yebesi and R. Tingle, 2005. Occupational exposure to crystalline silica dust in the United States, 1988-2003. Environ. Health Perspect., 113: 255-260.
5. Tungu, A.M., M. Bratveit, S.H. Mamuya and B.E. Moen, 2015. Reduction in respiratory symptoms among cement workers: A follow-up study. Occup. Med., 65: 57-60.
6. Mariammal, T., A.J. Amutha and R. Sornaraj, 2012. Work related respiratory symptoms and pulmonary function tests observed among construction and sanitary workers of Thoothukudi. Int. J. PharmTech Res., 4: 1266-1273.
7. Flanagan, M.E., N. Seixas, M. Majar, J. Camp and M. Morgan, 2003. Silica dust exposures during selected construction activities. AIHA J., 64: 319-328.
8. Bakke, B., B. Ulvestad, P. Stewart and W. Eduard, 2004. Cumulative exposure to dust and gases as determinants of lung function decline in tunnel construction workers. Occup. Environ. Med., 61: 262-269.
9. Sivaharini, S., S. Preetha and J. Priya, 2018. Evaluation of pulmonary function test in construction workers. Drug Invention Today, 10: 2148-2151.
10. Tavakol, E., M. Azari, R. Zendehdel, S. Salehpour, S. Khodakrim, S. Nikoo and B. Saranjam, 2017. Risk evaluation of construction workers' exposure to silica dust and the possible lung function impairments. Tanaffos, 16: 295-303.
11. Miller, M.R., J. Hankinson, V. Brusasco, F. Burgos and R. Casaburi *et al.*, 2005. Standardisation of spirometry. Eur. Respir. J., 26: 319-338.
12. Dweik, R.A., P.B. Boggs, S.C. Erzurum, C.G. Irvin and M.W. Leigh *et al.*, 2011. An official ATS clinical practice guideline: Interpretation of exhaled nitric oxide levels (FE_{NO}) for clinical applications. Am. J. Respir. Crit. Care Med., 184: 602-615.
13. Al-Neaimi, Y.I., J. Gomes and O.L. Lloyd, 2001. Respiratory illnesses and ventilatory function among workers at a cement factory in a rapidly developing country. Occup. Med., 51: 367-373.
14. Poornajaf, A., H. Kakooei, M. Hosseini, F. Ferasati and H. Kakaei, 2010. The effect of cement dust on the lung function in a cement factory, Iran. Int. J. Occup. Hygiene, 2: 74-78.
15. Mwaiselage, J., M. Bratveit, B. Moen and Y. Mashalla, 2004. Cement dust exposure and ventilatory function impairment: An exposure-response study. J. Occup. Environ. Med., 46: 658-667.

16. Noor, H., C.L. Yap, O. Zolkepli and M. Faridah, 2000. Effect of exposure to dust on lung function of cement factory workers. Med. J. Malaysia, 55: 51-57.
17. Yang, C.Y., C.C. Huang, H.F. Chiu, J.F. Chiu, S.J. Lan and Y.C. Ko, 1996. Effects of occupational dust exposure on the respiratory health of Portland cement workers. J. Toxicol. Environ. Health, 49: 581-588.
18. Meo, S.A., A.M. Al-Drees, A.A. Al Masri, F. Al Rouq and M. Abdul Azeem, 2013. Effect of duration of exposure to cement dust on respiratory function of non-smoking cement mill workers. Int. J. Environ. Res. Public Health, 10: 390-398.
19. Mandal, M.A. and R. Majumder, 2013. Assessment of pulmonary function of cement industry workers from West Bengal, India. Progr. Health Sci., 3: 65-77.
20. Kamaludin, N.H., N. Shahira, A. Razlan and J. Jalaludin, 2018. Association between respirable dust exposure and respiratory health among cement workers. Malays. J. Med. Health Sci., 14: 78-86.
21. Sitalakshmi, R., P. Saikumar and P. Jeyachandran, 2016. Civil construction work: The unseen contributor to the occupational and global disease burden. Indian J. Occup. Environ. Med., 20: 103-108.
22. Purdue, M.P., L. Gold, B. Jarvholm, M.C. Alavanja, M.H. Ward and R. Vermeulen, 2007. Impaired lung function and lung cancer incidence in a cohort of Swedish construction workers. Thorax, 62: 51-56.
23. Tantisuwat, A. and P. Thaveeratitham, 2014. Effects of smoking on chest expansion, lung function and respiratory muscle strength of youths. J. Phys. Ther. Sci., 26: 167-170.
24. Kenfield, S.A., E.K. Wei, B.A. Rosner, R.J. Glynn, M.J. Stampfer and G.A. Colditz, 2010. Burden of smoking on cause-specific mortality: Application to the Nurses' Health Study. Tobacco Control, 19: 248-254.
25. Nordby, K.C., A.K.M. Fell, H. Noto, W. Eduard and M. Skogstad *et al*., 2011. Exposure to thoracic dust, airway symptoms and lung function in cement production workers. Eur. Respir. J., 38: 1278-1286.
26. Isabel, U., C. Alberto, Q.J. Maria, M. Nerea, B. Xavier and S. Jordi, 2005. Smoking habit, respiratory symptoms and lung function in young adults. Eur. J. Public Health, 15: 160-165.
27. Musa, R., L. Naing, Z. Ahmad and Y. Kamarul, 2000. Respiratory health of rice millers in Kelantan, Malaysia. Southeast Asian J. Trop. Med. Public Health, 31: 575-578.
28. Cerveri, I., S. Accordini, G. Verlato, A. C orsico and M.C. Zoia *et al*., 2001. Variations in the prevalence across countries of chronic bronchitis and smoking habits in young adults. Eur. Respir. J., 18: 85-92.
29. Ambrose, J.A. and R.S. Barua, 2004. The pathophysiology of cigarette smoking and cardiovascular disease: An update. J. Am. Coll. Cardiol., 43: 1731-1737.