ORIGINAL SCIENTIFIC PAPER

SIGURNOST 56 (4) 315 - 322 (2014)

O.G. Akanbi, O. Ismaila, W. Olaoniye, K. T. Oriolowo, A. Odusote*

ASSESSMENT OF POST-WORK PEAK EXPIRATORY FLOW RATE OF WORKERS IN CEMENT COMPANY

UDK 666.9;[616.24:613.6
RECEIVED: 2013-09-09
ACCEPTED: 2014-09-09

SUMMARY: Exposure to cement dust has been linked to lung function impairment. However, there are few such studies in Nigeria. The main aim of this study was to assess the post-work Peak Expiratory Flow Rate (PEFR) of workers in a cement company.

Sixty workers in a cement factory were randomly selected; thirty were regarded as workers exposed to cement dust and the remaining as unexposed workers. Both groups were non smokers, had no cardiopulmonary diseases or symptoms during the time of study. Wrights Peak Flow Meter was used for measuring lung functions before and after work for the exposed and unexposed workers. A statistical package, SPSS 16.0 was used for the analysis.

There were no significant differences between the pre-work and post-work PEFR between the exposed and unexposed workers though there were differences. The exposed workers had reduced PEFR compared with their unexposed counterparts. However, there were significant differences between the pre-work and post-work PEFR for both the exposed and unexposed workers with the pre-work values lower than the post-work values.

It was found that all workers in the cement industry are exposed to cement dust which reduces the lung volume and results in lung function impairment. It is suggested that efforts should be geared towards cleaner production by recognizing where and when cement dust is generated and by planning ahead to eliminate, control or recycle the dust at the source.

Key words: *cement dust, PEFR, lung function*

INTRODUCTION

It has been estimated that an average of over 4 per cent of the total gross national product of all the countries in the world is spent on the annual losses resulting from work-related diseases and injuries in terms of compensation, loss of productivity, insurance premiums and medical expenses, etc. *(Takala and Niu, 2003)*. One of the major work-related illnesses is occupational lung disease that is usually induced by extended exposure to irritating or toxic substances *(Meo, 2004)*. This exposure to irritating or toxic substances results in lung function impairment, which is most common in industrial plants especially in the cement *(Meo et al., 2002)*, wood *(Liou et al., 1996)* and welding *(Meo, 2003)* industries. Exposure to Portland cement dust has long been associated with the prevalence of respiratory symptoms *(Alakija et al., 1990; Yang et al., 1996; Abrons et al., 1997)*, varying degrees

*Olusegun Gabriel Akanbi, Ph.D., Department of Industrial and Production Engineering, University of Ibadan, Ibadan, Nigeria, Olasunkanmi Ismaila, Ph.D. (ismailaso@funaab.edu.ng), Department of Mechanical Engineering, Federal University of Agriculture, P. M. B. 2240, Abeokuta, Nigeria, Wasiu Olaoniye, M.Eng., Department of Industrial and Production Engineering, University of Ibadan, Ibadan, Nigeria, Kolawole Taofik Oriolowo, M.Eng., Department of Industrial and Production Engineering, University of Ibadan, Ibadan, Nigeria, Adebayo Odusote, M.Eng., Department of Mechanical Engineering, Federal University of Agriculture, P. M. B. 2240, Abeokuta, Nigeria.

of airway obstruction and reduction in lung function *(Noor et al., 2000)*. It may also lead to acute post-work reduction in Peak Expiratory Flow (PEF) *(Mengesha and Bekele, 1997)*.

In developing countries millions of people work daily in dusty environments, especially in the cement industry. A number of dust-related studies conducted in Portland cement production plants are available. Their workers can be exposed to the raw materials used in cement production (limestone, chalk, clay and shale), to clinker, as well as to Portland cement dust. The exact nature of the dust exposure experienced by cement plant workers has not been characterized in any of the studies. Consequently, one cannot exclude the possibility that any observed adverse health effects may be due, at least in part, to the raw materials and intermediates in cement production. In the available studies, dust exposure has been expressed either in terms of respirable dust, or "total dust", or both. This raises two issues, one concerning the ratio between total and respirable dust (given that cement dust is very fine and one might expect a high proportion of the total dust to be respirable), and the other concerning the meaning of the term "total" dust.

Abou-Taleb et al. *(1995)* and Rafnsson et al. *(1997)* stated that prolonged exposure to cement dust can develop local and systemic effects like cough, phlegm production, chest tightness, impairment of lung functions, pneumoconiosis, skin irritation, dermatitis, skin burn, conjunctivitis, headache, fatigue and also carcinoma of the lungs, stomach and colon. According to previous studies reporting oral cavity problems, the frequently reported symptoms in cement mill workers are inflammation of gums/gingivitis, calculus and pockets formation, dental caries, loss of surface area of teeth and also periodontal disease *(Tuominen and Tuominen, 1992)*.

Health and Safety Executive *(1994)* noted evidence that repeated exposure to Portland cement produces chronic bronchitis and impaired pulmonary function, but firm conclusions could not be drawn because of limitations in the available data. Fell et al. *(2003)* observed that the effects of long-term exposure remain poorly studied, particularly because there are no longitudinal prospective studies.

The health effects of cement dust on humans necessitated that attention be given to their study. To assess respiratory function, parameters such as vital capacity, FEV1 (Forced expiratory volume in 1 second), FEV1% (Forced expiratory volume in 1 second as a percentage of forced vital capacity), Forced Vital Capacity (FVC) and PEFR (Peak expiratory flow rate) *(Alakija et al., 1990; Al-Neaimi et al., 2001; Meo et al., 2002; Badri and Saeed, 2008)* were examined. Among them, the Peak Expiratory Flow Rate (PEFR) is the cheapest and easiest method in identifying and assessing the degree of airflow limitations of individuals *(Debray et al., 2008)*. It is also an accepted index of pulmonary function, widely used in respiratory medicine (Higgins, 1997). Very few reports *(Alakija et al., 1990; Azah et al., 2002; Merenu et al., 2007)* on the effects of cement dust exposure for cement factory workers in Nigeria exist. To the best of our knowledge, there is no report of any study on the effects of cement dust on the respiratory system of workers in Itori, Ogun State, Nigeria. This study was embarked upon in view of the controversy concerning the effects of cement dust exposure on lung function and the paucity of such data in Ogun State in particular and Nigeria in general.

MATERIALS AND METHODS

Worksite

The study was conducted at Purechem Portland Cement Factory in Onigbedu Village, Itori, Ogun State, Nigeria between July and August 2010. The factory started production in 2005 and currently employs 125 permanent workers in addition to 50 contract workers, with a production of 300 metric tons of cement daily. The factory has four major departments: Production (Crusher, Raw Mill, Kiln, Cement Mill and Packing Section), Engineering (Mechanical and Electrical Section), Mining, and Administration (Cashier, Administrative Officer, Security and Marketing Section).

Subjects

Thirty (30) workers in kiln, packing, and crusher sections of the factory with no symptoms of respiratory diseases prior to work were randomly selected as the exposed workers due to their high level of exposure to cement dust *(Alakija et al., 1990; Mwaiselage et al., 2005; Merenu et al., 2007).* An unexposed (controlled) group was made up of thirty (30) workers randomly selected from amongst the factory administration staff. The permission of the factory management and consents of the participants were obtained prior to the start of the study.

Participants were notified several days before the commencement of the study and were given appropriate instructions. The physical characteristics of the workers included weight and height measured with the use of weighing scale and stadiometer respectively.

Data were collected by an interviewer-administered structured questionnaire aiming to determine: years of exposure as deduced from date of employment, site or position at the workplace, and use of safety gadgets such as dust masks. Information on general health, history of past disease(s) and habits such as smoking was gathered as well.

The workers were interviewed to establish their level of literacy. It was found that most respondents could not write, thus, they were all interviewed and the questionnaire was completed according to responses obtained. The introductory part of the questionnaire included age, years of education, years in other industries, years in different sections of the cement factory, non-use of respiratory protective gear, past respiratory diseases, and smoking habits, according to the British Medical Research Council questionnaire *(BMRC,1960).*

A peak flow meter measures the workers' maximum speed of expiration, or peak expiratory flow rate (PEFR or PEF). Peak flow readings are higher when workers are well, and lower when the airways are constricted.

Measurement of PEFR was done with a mini Wright peak flow meter (Clement Clarke International, UK). Prior to measuring the subjects' PEFR, the use of the instrument was repeatedly demonstrated and explained. The PEFR test was performed in the standing position with the peak flow meter held horizontally. The subjects were asked to take as deep a breath as possible and then blow out as hard and as quickly as possible. Each subject performed the test 3 times and the highest of the three readings was recorded as the final individual peak flow value *(Afolabi et al., 1996; Al-Neaimi et al., 2001; Ghosh and Barma, 2007).*

Statistical Analysis

The statistical analysis was performed using the SPSS 16.0 statistical package. The paired samples t-test in the package was used to test the differences between the variables of the exposed and unexposed workers and for the descriptive analysis.

RESULTS

Table 1 shows the descriptive statistics of the physical parameters and PEFR of exposed workers, while Table 2 shows those of the unexposed (controlled) workers. The mean age of the exposed workers was 31.3 years (SD = 8.1 years) and the mean height was 167.9 cm (SD = 7.5 cm). The workers had spent an average of 3.4 years (SD = 1.6 years) at their various sections in the plant and had a mean BMI of 22 kg/m^2 (SD = 2.5 kg/m^2). Similarly, the unexposed workers' mean age was 34.7 years (SD = 7.7 years) and their mean height was 173.2 cm (SD = 6.5 cm). The unexposed workers had a mean BMI of 22.2 kg/m^2 (SD = 3.5 kg/m^2) and they had worked for an average of 3.1 years (SD = 1.5 years). The mean of the pre-work PEFR for the exposed workers was 406.3 L/min (SD = 95.1 L/min) with a post-work PEFR of 354.5 L/min (SD = 104.1 L/min). The mean of the pre-work PEFR for the unexposed workers was 419.0 L/min (SD = 105.1 L/min) with a post-work PEFR of 377.7 L/min (SD = 96.2 L/min). No variables except the height of the exposed and unexposed workers were significantly different, though there were noticeable differences in their means (Table 3). However, there were significant differences between the pre-work and post-work PEFR for both the exposed (p = 0.000, t = 5.743) and unexposed workers (p = 0.000, t = 6.522), with the pre-work values lower than the post-work values.

Table 1. Descriptive statistics of physical parameters and PEFR of exposed workers

Tablica 1. Opisna statistika fizikalnih parametara i PEFR-a kod izloženih radnika

Parameters	N	Minimum	Maximum	Mean	Std. Deviation
AGE (years)	30	19.00	49.00	31.3	8.1
HEIGHT (cm)	30	147.50	180.50	167.9	7.5
WEIGHT (kg)	30	48.00	90.00	61.9	8.6
BMI (kg/m^2)	30	17.70	27.60	22	2.5
EXPERIENCE (years)	30	1.00	8.00	3.4	1.6
PRE-WORK PEFR (L/min)	30	260.00	620.00	406.3	95.1
POST-WORK PEFR (L/min)	30	185.50	570.00	354.5	104.1

Table 2. Descriptive statistics of physical parameters and PEFR of unexposed (controlled) workers

Tablica 2. Opisna statistika fizikalnih parametara i PEFR-a kod neizloženih radnika (kontrolna skupina)

Parameters	N	Minimum	Maximum	Mean	Std. Deviation
AGE (years)	30	23.00	50.00	34.7	7.5
HEIGHT (cm)	30	161.50	186.50	173.2	6.5
WEIGHT (kg)	30	53.00	88.00	66.5	9.3
BMI (kg/m^2)	30	18.20	32.40	22.2	3.5
EXPERIENCE (years)	30	1.00	5.00	3.1	1.5
PRE-WORK PEFR (L/min)	30	240.00	670.00	419.0	105.1
POST-WORK PEFR (L/min)	30	230.00	650.00	377.7	96.2

Table 3. Comparison of physical parameters and PEFR on exposed and unexposed workers

Tablica 3. Usporedba fizikalnih parametara i PEFR-a kod izloženih i neizloženih radnika

Variables	N	Exposed group (n=30)	Controlled group (n=30)	P –value
AGE (years)	30	31.3 (±8.1)	34.7(±7.5)	0.130*
HEIGHT (cm)	30	167.9 (±7.5)	173.2(±6.5)	0.014^
WEIGHT (kg)	30	61.9(±8.6)	66.5(±9.3)	0.076*
EXPERIENCE (years)	30	3.4(±1.6)	3.1(±1.5)	0.534*
PRE-WORK PEFR (L/min)	30	406.3(±95.1)	419(±105.1)	0.584*
POST-WORK PEFR (L/min)	30	354.5(±104.1)	377.7(±96.2)	0.347*
BMI (kg/m^2)	30	22(±2.5)	22.2(±3.5)	0.753*

* not significant ^ significant

DISCUSSION

The study evaluated the PEFR of workers before and after the day's work. No significant difference existed between the exposed and unexposed workers. This is in agreement with earlier studies *(Merenu et al., 2007; Fell et al., 2003; Yang et al, 1993)*, but does not support some other studies *(Yang et al., 1996; Alakija et al., 1990; Oleru, 1984)*. The existence of non-significant difference between the exposed and unexposed workers could be due to the average number of years the workers spent in the plant, which was about 3 years and may not be long enough for any significant difference, especially as the mean values of PEFR for unexposed workers were higher than for the exposed workers. It may also be because the unexposed workers were older, heavier or had worked fewer years than the exposed workers. However, there were significant differences between the pre-work and post-work PEFR for both the exposed and unexposed workers with the pre-work values lower than the post-work values. This suggests that cement dust could result in lung function impairment (based on PEFR) and that all workers in the cement industry are exposed to cement dust, which is against the widely held view that some categories of workers are more exposed than others. Mwaiselage et al. *(2005)* reported that workers who were in close contact with the production processes had high exposure to total cement dust (11-230 mg/m^3) and respirable cement dust (2-46 mg/m^3). Similarly, Kakooei et al. *(2012)* found that total dust was higher in the crusher (20.84 mg/m^3), packing (17.29 mg/m^3), kiln (16.78 mg/m^3), cement mill (14.90 mg/m^3), raw mill (10.44 mg/m^3), and lower in maintenance (3.77 mg/m^3) and administration (1.01 mg/m^3).

Chronic exposure to cement dust may reduce the lung volume when dust comes in contact with water along the lung and forms particles which attach themselves to the lung. Cement dust has been identified as the cause of wheezing and shortness of breath *(Mirzaee et al., 2008),* high rate of bronchial asthma *(AbuDhaise et al., 1997; Al-Neaimi et al., 2001; Laraqui et al., 2001),* and high rate of breathlessness *(Abrons et al., 1988).* Contrary to some studies claiming that protective gadgets were not provided in cement companies *(Al-Neaimi et al., 2001)*, immediate observation, interviews with workers and responses recorded in the questionnaires proved that protective gadgets were provided and used. However, the significant difference between the pre-work and post-work values of PEFR suggests that the gadgets were either not effective or were not used as suggested by the manufacturers. The most successful tool of prevention of respiratory diseases from cement dust is to minimize exposure. However, this is not a practical approach, as cement dust is an unavoidable by-product. It is therefore essential that efforts should be geared towards cleaner production by recognizing where and when cement dust is generated and by planning ahead to eliminate, control or recycle the dust at the source. To control cement dust, ventilation systems should be used in conjunction with hoods and enclosures covering transfer points and conveyors. Drop distances should be minimized by the use of adjustable conveyors, and dusty areas such as roads should be wetted down to reduce dust generation. There should also be appropriate storm water and runoff control systems to minimize the quantities of suspended material carried off site.

To safeguard the health of all workers the management should embark on safety training focused on hazards of exposure to cement dust, safety precautions and practices. The management should acquire effective protective gadgets, train their workers on the usage and ensure compliance. They should conduct regular periodic air monitoring to measure worker exposure to cement dust and to ensure that controls provide adequate protection for workers. The management should also provide periodic medical examinations for all workers who may be exposed to respirable cement dust.

CONCLUSIONS

The current study has shown that working in cement dust infested environment could be associated with the impairment of lung function due to a reduction in lung volume. The health of workers should therefore be safeguarded by implementing safety training in hazards of exposure for the workers, teaching them to understand the need for using their nose covers always and correctly. The management should also control cement dust generation by opting for a cleaner production process that will reduce cement dust, thereby enhancing production efficiency while improving the health of their workers.

REFERENCES

Abou-Taleb, A.N, Musaiger, A.O, Abdelmoneim, R.B.: Health status of cement workers in the United Arab Emirates, *Social Health Research Journal,* 115, 1995, 378-81.

Abrons, H.L, Petersen, M.R., Sanderson, W.T., Engelberg, A.L., Harber, P.: Chest radiography in Portland cement workers, *Journal of Occupational and Environmental Medicine,* 39, 1997, 104-54.

AbuDhaise, B.A., Rabi, A.Z., al Zwairy, M.A., el Hader, A.F., el Qaderi, S.: Pulmonary manifestations in cement workers in Jordan, *International Journal of Occupational Medicine and Environmental Health,* 10, 1997, 4, 417-28.

Afolabi, B.M., Ibrahim, M.M., Ekanem, E.E.: Pathological indices of occupational exposure at a petrochemical industry in Nigeria: a preliminary study, *African Journal of Medicine Science,* 25, 1996, 171-177.

Alakija, W., Iyawe, V.I., Jarikre, L.N., Chiwuzie, J.C.: Ventilatory function of workers at Okpella cement factory in Nigeria. *West African Journal of Medicine,* 9, 1990, 187-192.

Al-Neaimi, Y.I., Gomes, J., Lloyd, O.L.: Respiratory illnesses and ventilatory function among workers at a cement factory in a rapidly developing country. *Occupational Medicine* (Lond), 51, 2001, 6, 367-373.

Arbrons, H.L., Peterson, M.R., Sanderson, W.T., Engelberg, A.L., Harber, P.: Respiratory symptoms, ventilatory function and environmental exposure in Portland cement workers, *British Journal of Industrial Medicine,* 45, 1988, 6, 368-375.

Azah, N., Antai, A.B., Peters, E.J., Osim, E.E.: Effect of exposure to dust generated from crushing of granite rocks on the lung function of southeastern Nigerian children. *Nigerian Journal of Physiological Science,* 7, 2002, 1-2, 42-47.

Badri, O.A., Saeed, A.M.: Effect of exposure to cement dust on lung function of workers at Atbara Cement Factory, *Kharoum Medical Journal*, 1, 2008, 2, 81-84.

Debray, P., Shreevatsa, B.M., Sen, T.K., Roy, S., Saha, C.G.: A Comparative Study of the Peak Expiratory Flow Rate of Indian and Nepalese Young Adults in a Teaching Institute, *Journal of Nepal Medical Association,* 47, 2008, 169, 7-11

Fell, A.K., Thomassen, T.R., Kristensen, P., Egeland, T., Kongerud, J.: Respiratory symptoms and ventilatory function in workers exposed to Portland cement dust. *Journal of Occupational and Environmental Medicine,* 45, 2003, 1008-14

Ghosh, T., Barman, S.: Respiratory Problems of Workers in the Zarda Industry in Kolkata, India. *International Journal of Occupational Safety and Ergonomics (JOSE),* 13, 2007, 1, 91–96.

Health and Safety Executive: *Portland Cement Dust,* Criteria document for an occupational exposure limit. EH65/12 HSE Books, Sudbury, Suffolk, 1994.

Higgins, B.: Peak expiratory flow variability in the general population. *European Respiratory Journal,* 24 (Suppl), 1997, 45S-48S.

Kakooei, H., Kakouei, A.A., Poornajaf, A., Ferasaty, F.: Variability in Total Dust Exposure in a Cement Factory, *Industrial Health,* 50, 2012, 64–68.

Laraqui, C.H., Laraqui, O., Rahhali, A.: Prevalence of respiratory problems in workers at two manufacturing centers of ready-made concrete in Morocco, *International Journal of Tuberculosis and Lung Disease,* 5, 2001, 11, 1051-1058.

Mengesha, Y.A., Bekele, A.: Effects of acute exposure to different occupational dusts on pulmonary function indices of factory workers in Ethiopia, *African Newsletter of Occupational Health Safety,* 7, 1997, 1, 8-9.

Meo, S.A.: Effects of Duration of Exposure to Wood Dust on Peak Expiratory Flow Rate among Workers in Small Scale Wood Industries, *International Journal of Occupational Medicine and Environmental Health,* 17, 2004, 4, 451 — 455

Meo, S.A., Azeem, M.A., Ghori, M.G., Subhan, M.M.: Lung function and surface electromyography of intercostal muscles in cement mill workers, *International Journal Occupational Medicine and Environmental Health,* 15, 2002, 3, 279-287.

Merenu, I.A., Mojiminiyi, F.B.O., Njoku, C.H., Ibrahim, M.T.O.: The Effect of Chronic Cement Dust Exposure on Lung Function of Cement Factory Workers in Sokoto, Nigeria. *African Journal of Biomedical Research,* 10, 2007, 2, 139-143

Mirzaee, R., Kebriaei, A., Hashemi, S.R., Sadeghi, M., Shahrakipour, M.: Effects of exposure to Portland cement dust on lung function in Portland cement factory workers in Khash, Iran. *Iranian Journal of Environmental Health and Science Engineering, 5,* 2008, 3, 201-206.

Mohammad, I., Salma, A.I., Mustafizur Rahman, A.N. and Samsuzzoha, A.H.M.: ERGONOMICS AND DESIGN. *Proceedings of the 2011 International Conference on Industrial Engineering and Operations Management,* 2011

Noor, H., Yap, C. L., Zolkepli, O., Faridah, M.: Effect of exposure to dust on lung function of cement factory workers, *Medicine Journal of Malaysia,* 55, 2000, 51-57.

Oleru, U.G.: Pulmonary function and symptoms of Nigerian workers exposed to cement dust, *Environmental Research*, 33, 1984, 2, 379-285.

Rafnsson, V., Gunnarsdottir. H., Kiilunen, M.: Risk of lung cancer among masons in Iceland, *Occupational & Environmental Medicine,* 54, 1997, 184-188.

Takala, J., Niu, S.: *Responses to the equity challenge in safety and health at work: improvement of working conditions in equitable bases,* In: 27th International Congress on Occupational Health, 23-28 February 2003, Iguassu Falls, Brazil.

Tuominen, M., Tuominen, R.: Tooth surface loss and associated factors among factory workers in Finland and Tanzania Community, *Dental Health,* 2, 1992, 143-50.

Yang, C.Y., Huang, C.C., Chang, I.C., Lee, C.H., Tsai, J.T., Ko, Y.C.: Pulmonary function and respiratory symptoms of Portland cement workers in Southern Taiwan, *Kao Hsing I Hsueh Ko Hsueh Tsa Chih,* 9, 1993, 186-192.

Yang, C.Y., Huang, C.C., Chiu, H.F., Chiu, J.F., Lan, S.J., Ko, Y.C.: Effects of occupational dust exposure on the respiratory health of Portland cement workers, *Journal of Toxicology and Environmental Health,* 49, 1996, 581-8.

PROCJENA VRŠNOG IZDISAJNOG PROTOKA NAKON RADA KOD RADNIKA U TVORNICI CEMENTA

SAŽETAK: Izloženost cementnoj prašini povezana je s oštećenjem plućne funkcije. Međutim, u Nigeriji postoji vrlo malo studija na tu temu. Glavni je cilj ove studije utvrditi najveći vršni izdisajni protok (Peak Expiratory Flow Rate, PEFR) kod radnika u tvornici cementa.

Nasumično je odabrano šezdeset radnika; trideset za skupinu izloženu cementnoj prašini, a ostali za neizloženu skupinu. Obje su skupine bile nepušači, nisu imali srčanih ili plućnih bolesti niti drugih simptoma tijekom studije. Wrightov mjerač vršnog protoka upotrijebljen je za mjerenje funkcije pluća prije rada i poslije rada kod obje skupine. Za potrebe analize upotrijebljen je statistički paket SPSS 16.0.

Između dviju skupina nisu utvrđene značajne razlike u mjerenjima PEFR-a prije rada i poslije njega, ali bilo je razlika. Izloženi radnici imali su nižu vrijednost PEFR-a u usporedbi s neizloženima. Međutim, nađene su značanje razlike između PEFR-a prije rada i poslije rada za obje skupine, izloženih i neizloženih, s time da su vrijednosti prije rada bile niže od vrijednosti poslije rada.

Utvrđeno je da su svi radnici u proizvodnji cementa izloženi cementnoj prašini koja smanjuje obujam pluća i rezultira oštećenjem plućne funkcije. Predlaže se da se napori usmjere na postizanje čišće proizvodnje utvrđivanjem gdje i kada se cementna prašina stvara te planiranjem radnji kojima će se prašina ukloniti, nadzirati ili reciklirati na izvoru.

Ključne riječi: *cementna prašina, PEFR, plućna funkcija*

Izvorni znanstveni rad
Primljeno: 9.9.2013.
Prihvaćeno: 9.9.2014.