[1.]Adekunle Ibrahim MUSA

MATHEMATICAL APPROACH TO ESTIMATE THE PEAK EXPIRATORY FLOW RATE OF MALE BAKERS IN ABEOKUTA, NIGERIA

[1.]Department of Mechanical Engineering, Moshood Abiola Polytechnic, P.M.B 2210, Abeokuta, NIGERIA

Abstract: The study presented the mathematical approach to determine the Peak expiratory flow rate of male bakers in Abeokuta, Ogun State, Nigeria with the relationship of the peak expiratory flow rate and the anthropometrical parameters. A total of One hundred and Eighty (180) individuals were investigated with ninety (90) bakers (study group) who are exposed to flour dust and ninety (90) control subjects. The entire subject both study and control group are male. Peak expiratory flow rate (PEFR) and anthropometrical parameters were measured using mini-Wright peak flow meter (PFM 20, OMRON) and Detecto PD300MDHR (Cardinal Scale manufacturing company USA) column scale respectively. PEFR measured were compared using T-test and regression analysis. A mathematical model was developed to determine the peak expiratory flow rate (PEFR) with four factors of body mass, height, age and year of exposure where applicable. The study showed that PEFR in bakers was 182.67 ± 16.34 L/min as against 287.67 ± 17.03 L/min for control group from the regression analysis. Similarly, the model revealed that baker has 182.69 L/min and 285.77 L/min for control group. The Study concluded that using the developed model will serve as a great importance to workers to determine the level of their health and subsequently prevent untimely death.
Keywords: bakery, flour, dust, workers, peak expiratory flow rate, exposure, asthma

INTRODUCTION

The degree of obstruction of airways in the lung needed to be checked as bakers have being adjudged to have highest incidence rate of occupational heart diseases (Ige and Awoyemi 2002). Different researchers have performed extensive work on the determination of peak expiratory flow rate of individuals to actually prevent the unwanted death among workers (Musa, 2015, Musa et al, 2016). Baatjies et al, (2010) research established the physiological status of bakery workers like allergic conditions, respiratory problems due to the daily exposure to flour dust.

The respiratory effects of exposure to flour dust are influenced by the dose and duration of exposure (Meo, 2006) and these differ from one working environment to other. Rafnsson et al., (1997) presented the peak expiratory flow rate of a healthy adult and non-exposed to dust between 300-600L/min with variation of age, body weight, height and gender. Musa et al., (2016a) investigated the peak expiratory flow rate (PEFR) of female bakers with about One hundred and twenty participant. The results showed that female bakers have 158.17±12.55L/min PEFR but did not consider male bakers as participant in the research. Elebute and Femi Pearse (1971) established values of PEFR in Nigeria with 142 healthy adults participated. The study showed that the mean value of male PEFR was 582±88.3L/min and 385±65.7L/min for female respectively.

Musa et al., (2016b) also investigated the relationship between the PEFR and the anthropometric parameters to determine the model equation for the determination of female bakers PEFR. The result showed that a female baker has 158.07L/min PEFR as against 267.96L/min for the control group. Hence, the aim of this research is to develop a statistical model to predict the peak expiratory flow rate of male bakers and compare it with non-bakers.

MATERIALS AND METHODS

The study was conducted in Abeokuta with One hundred and Eighty (180) participants. Peak expiratory flow rate and anthropometric parameters of the participant were measured and recorded with ninety (90) adult male bakers and ninety (90) healthy male adult selected as the control group to the bakers. The age of the participated bakers range between 21-28years and they have involved in bakery business between 5month and 8years. The control group was of the same age bracket with the bakers. Both bakers and control group were assumed not to have no earlier reported systematic disease. Similarly, individual with smoking habit or suffering from any respiratory illness were exempted from the study.

The PEFR was measured with mini-Wright peak flow meter, (PFM 20, OMRON) (Figure 1). Three readings were taken from each subject in standing position and the best of the three were considered as Peak Expiratory Flow meter reading for that subject.

Figure 1: mini-Wright peak flow meter

Detecto PD300MDHR (Cardinal Scale manufacturing company, USA) column scale with digital height rod (Figure 2) was used to measure body mass (kg) and height (cm) of the subjects simultaneously.

Figure 2: Detecto (PD300DHR column scale with digital height rod

Questionnaire was also administered to the participant. The data collected from the questionnaire includes the detailed demographic data such as age, marital status, education level, smoking habit, duration of flour dust exposure and working experience. Figure 3 below showed the subjects performing measurement of PEFR.

Reference to the data collected, the relationship between the PEFR and anthropometric parameters existed and this was used to design the multi-linear regression model where PEFR remain the dependant of the anthropometric parameters.

The model follows the trends in equation (1) and (2) respectively (Musa et al, 2016b).

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + \ldots + b_nx_n \quad (1)$$

$$PEFR = a + b_1(\text{Body mass}) + b_2(\text{Height}) + b_3(\text{Age}) + b_4(\text{years of exposure}) \quad (2)$$

where, a is the constant and b is the coefficient of regression. Each coefficient b represent the effect of the independent variable y. b_4 is only applicable to bakers only.

Figure 3: Subjects (Bakers) performing measurement of PEFR

RESULTS AND DISCUSSION

Table 1 below showed the descriptive statistic and the T-test (one sample test) analysis of the investigated participants.

The results obtained were expressed using mean ± standard deviation, T-test for the two groups' comparisons and regression analysis.

Table 1: Descriptive statistics/ T-test (one sample test) for Male Subjects

	MALE (STUDY)					
	N	Mean	S. E Mean	Std. Dev	t	df
Body mass (kg)	90	61.508	0.4201	3.9851	146.422	89
Height (cm)	90	170.184	0.3953	3.7501	430.523	89
PEFR (L/min)	90	182.667	1.7223	16.3391	106.060	89
Age (yrs)	90	28.04	0.260	2.467	107.829	89
Yrs o f Expo	90	2.50	0.079	0.753	31.485	89
	MALE (STUDY)					
	N	Mean	S. E Mean	Std. Dev	t	df
Body mass (kg)	90	65.811	0.4837	4.5885	136.065	89
Height (cm)	90	170.904	0.4538	4.3050	376.618	89
PEFR (L/min)	90	287.667	1.7951	17.0294	160.255	89
Age (yrs)	90	27.97	0.327	3.107	85.405	89
Yrs o f Expo	90	2.50	0.079	0.753	31.485	89

Table 2 and Table 3 below showed the result of multi-linear regression analysis between the peak expiratory flow rate and the anthropometric parameters from the analysis, a model to predict the peak expiratory (PEFR) of the subject was derived.

Table 2: Regression analysis between PEFR and other parameter for Male bakers

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	277.033	71.637		3.867	0.000
	Body mass	-0.480	0.477	-0.117	-1.007	0.317
	Height	-0.292	0.497	-0.067	-0.587	0.559
	Age	0.449	0.629	0.068	0.714	0.477
	Yr of Expo	-11.122	2.002	-0.513	-5.555	0.000
a. Dependent Variable: PEFR						

Table 3: Regression analysis between PEFR and other parameter for Male (control)

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	-21.985	61.321		-0.359	0.721
	Body mass	2.035	0.359	0.548	5.669	0.000
	Height	0.953	0.347	0.241	2.748	0.007
	Age	0.461	0.525	0.084	0.877	0.383
a. Dependent Variable: PEFR						

From Table 2 and the trend in Equation (2), the model for the determination of PEFR for Male baker can be deduced and written as in Equation (3).

$$PEFR_{Male\ baker} = 277.03 - 0.48(Body\ mass) - 0.29(height) + 0.449(Age) - 11.12(yr\ of\ exposure) \quad (3)$$

Similarly, from Table 3 and the trend in Equation (2), the model for the determination of PEFR for the men not exposed to dust (control study) can be deduced and written as in Equation (4).

From table 3 above the model for the determination of PEFR for non-dust exposed Male can be deduced as,

$$PEFR_{Male\ control} = -21.99 + 2.04(Body\ mass) + 0.95(height) + 0.46(Age) \quad (4)$$

Equation 3 and equation 4 showed the regression equations where PEFR remain the dependent variable to determine the mathematical model. The applied anthropometrical parameters such as body mass, height, age and year of exposure played a major role in the determination of this model and they were considered as independent variables.

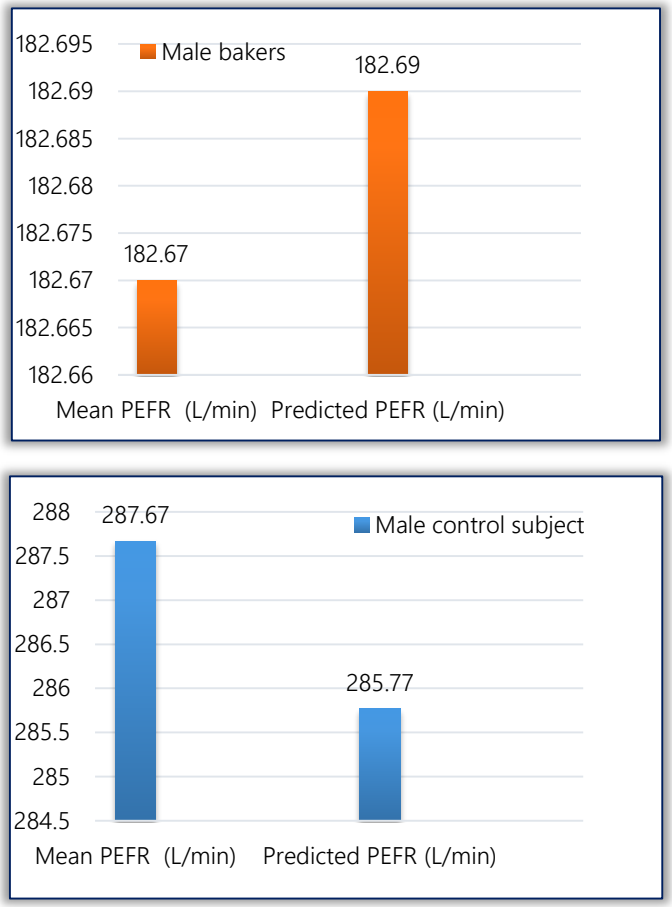

Figure 4: Comparison of Mean and Predicted PEFR (L/min)

Host et al (1994) and Verma et al (2000) showed that an accuracy of predicted value of PEFR will be higher when age is considered along with height. Figure 4 showed the direct and the calculated measurement of PEFR for comparison. The figure 4 showed that the mean and predicted PEFR were closely similar (±0.02L/min). This little difference may be due to the instrument variations and the physical characteristics of the studied individual. PEFR (L/min) predicted were based on the multi-linear regression equation and this was found very consistent when compared with other study (Benjaponpitak et al 1999).

Musa et al (2016b) determine the female bakers and female flour non-exposed individual model. This model was in variance with the present study but similar trend was adopted. Musa et al (2016b) showed that the predicted PEFR for females both bakers and control study were 158.07L/min and 267.96L/min respectively.

But the present study which were male dominant showed 182.69L/min and 285.77L/min respectively for bakers and the control. This result was compared with Abou Taleb et al (1995), Rafnsson et al (1997) and Vestbo et al (1991) and this revealed that the bakers were not healthy and this might have affected the lung obstruction.

CONCLUSION

The results obtained in the study can be used as a standard PEFR for any male individual who are exposed or not exposed to the flour dust. These equations can also play a major role in determining the PEFR of any male individual in the absence of the hand-held devices for the measurement.

Further study is also required to develop a model that will be devoid of gender either male or female. This will allow for wide range of determining the PEFR of individual who are exposed or non-exposed to flour dust.

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