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Assessment of Peak Expiratory Flow Rate of Bakers in Osun, Lagos and Oyo States, Nigeria

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Abstract
Bakers are exposed to flour dust; thence, they face various tremendous health problems such as asthma and some other respiratory illnesses, which may be aggravated when combined with improper awareness of ways of protection and ignorance by bakery employers and employees. This study focused on bakers' speed of expiration in the selected geographical locations by assessing the Peak Expiratory Flow Rate (PEFR) of the bakers and also establishing equations involving their anthropometric parameters. A total of 435 subjects were considered for each group, classified as a test group and a control group. The PEFR and anthropometric data which includes age, height, weight, and length of chest of bakers and non-bakers were collected using a Mini-Wright peak flow meter and Detecto PD300MDHR column scale. A self-reporting questionnaire was administered to each of the bakers. SPSS (version 21) and MS Excel (version 2016) were used to analyze the data. Descriptive and inferential statistics, as well as T-test analysis, were used to compare the data of the two groups. The study showed that bakers in Agege, Osogbo, and Ibadan have mean PEFR of 372.37, 386.44, and 389.31l/min, respectively, while non-bakers in Agege, Osogbo, and Ibadan have mean PEFR of 487.50, 473.32, and 473.80l/min, respectively. It was observed that some of the factors that affect the low level of PEFR are lack of personal protective equipment, negligence to health tips, carefree attitude to guides, and the principle of safety in bakery industries. It is therefore recommended that require training/retraining, awareness creation, and use of personal protective equipment should be employed as safety interventions highly necessary in the baking industry.

Keywords: *Bakery, Flour Dust, Exposure, Occupational Asthma*

1.0 INTRODUCTION

Peak expiratory flow rate (PEFR) is the maximum flow rate generated during a forceful exhalation, starting from full lung inflation. A person's PEFR primarily reflects large airway flow and depends on voluntary effort and muscular strength [1]. Maximal airflow occurs during the effort-dependent portion of the expiratory maneuver; thus, low values may be caused by a less than maximal effort rather than by airway obstruction. Nevertheless, the ease of measuring PEFR with an inexpensive small portable device has made it popular as a means of following the degree of airway obstruction in patients with asthma and other pulmonary conditions. PEFR primarily reflects large airway flow and depends on the voluntary effort and muscular strength of a person.

According to Safe Environments [2], flour dust is the product of processed (or milled) grains of wheat, rye, barley, sorghum, oat, or corn cereals which when exposed to, can have great health detriments such as changes in the performance of the lung, increased prevalence of chronic bronchitis, occupational asthma and respiratory symptoms. Symptoms from flour dust exposure include cough, wheeze, and shortness of breath (dyspnea), asthma, eye problems, conjunctivitis, rhinitis, and sinusitis. The most serious appears to be from occupational asthma which may occur even after thirty (30) years of exposure [3, 4]. Research has shown that bakers have symptoms with approximately eight (8) years of flour dust exposure than other professions. When compared with the general population, the increased prevalence of occupational asthma attributable to bakers appears to be 2-3 cases per 1000 person per year [5, 6]. Symptoms of exposure occur through two mechanisms viz, total inhalable flour dust acting as an irritant (between 4-10 mg/m^3) and, atopic or sensitized (due to previous exposures) having an allergic response at lower levels. Sensitivity to flour dust has been

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estimated to occur in non-atopic individuals at the lower range of 1-2.5 mg/m^3 [7]. Occupation-related respiratory symptoms, bronchial responsiveness, and sensitization are common in a modern bakery [8], which is due to exposure to flour particles in the bakeries. These exposures are thought to be responsible for 10-15% of asthma cases in adults, with disparities across the sectors [9, 10]. In grain-mill researches, workers show deteriorated lung function values compared to a matched control group due to exposure to grain dust. It was suggested that employees whose works are related to dust particles may be at a risk in the development of respiratory impairment [11, 12]. The normal values for Peak Expiratory Flow Rate for a healthy adult and non-exposed to dust are between 300-600l/min with a variation of age, body mass index (BMI)-mass per height, and gender [13, 14]. However, in a report by Adeniyi and Erhabor [15], a person's normal score should be within 20% of a person of the same age, sex, and height who does not have asthma. Ebomoyi and Iyawe [16], also established that sex, age, and height are the main factors influencing the rate of expiration. The study affirmed that the PEFR increases with age, weight, height, and chest circumference for young adults (between 18-30 years) of the same-sex, socio-cultural environment, and physical activities. A standardized normal peak flow rate may be obtained from a chart comparing an individual with a population without a breathing problem. The effects of exposure to this dust are detrimental to the health of the workers, thus, causing conjunctivitis, rhinitis, and dermal reactions, and bakers' asthma, which is the most severe and frequent manifestation of occupational allergy among all these effects.

The objectives of this study are to assess the peak expiratory flow rate of bread bakers and model equations involving anthropometric parameters like age, BMI, length of the chest, and year(s) of exposure.

2.0 MATERIALS AND METHODS

The target populations in this study are the employees and employers/managers of few selected bakeries in Lagos, Osun State, and Oyo State, from April 2019 to November 2019. The total number of subjects to be measured were selected according to Equation 1 [17]:

$$n = \frac{NZ^2pq}{d^2(N-1) + Z^2pq} \quad (1)$$

n = sample size, z = level of confidence according to the standard normal distribution (for a level of confidence of 95%, z = 1.96 (≈2)),p = estimated proportion of the population that presents the characteristic (when unknown, p = 0.5), q=(1-p = 0.5), d = tolerated margin of error (for example we want to know the real proportion within 5%), and N = total number of bakers in the selected location.

This study made use of a quantitative method of data collection. The test procedure was explained to the subjects accompanied by a demonstration of the procedure. The test subjects were allowed to sit for a few minutes to become mentally and physically relaxed and stable before testing. Tight clothing and waist belts were required to be loosened by subjects. Subjects were asked to stand right and inspire as much as possible and hold the sterile mouthpiece of the peak flow meter in the mouth with their lips forming a tight seal around the mouthpiece (Figure 1). They were then asked to expire rapidly and forcefully through the mouthpiece.

After preliminary trials, the best of three consecutive readings were recorded following the American Lung Society standard. Primary data using a self-reporting questionnaire, with PEFR data (using the peak expiratory flow meter (Figure 2)) and anthropometric data (using a weighing scale with Stadiometer (Figure 3) and anthropometric Vernier calipers (Figure 4)) were obtained.

Descriptive statistics and inferential statistics, as well as T-test analysis, were used to compare the data of the two groups. Statistical Package for the Social Sciences version 21 was used to analyze the data. Multilinear regression according to Equations 2 and 3 were used to model the PEFR as a dependent variable.

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_nx_n \quad (2)$$

$$\begin{aligned} PEFR &= a + b_1(age) + b_2(height) + b_3(body\ mass) \\ &+ b_4(length\ of\ chest) \\ &+ b_5(year\ of\ exposure\ to\ flour\ dust) \quad (3) \end{aligned}$$

where; a is the intercept, and b_n represents the influence of the independent variable (x_n) on the dependent variable Y.

In Equation 3, the number of years of exposure to flour dust, and its coefficient (b_5) apply to the study group (i.e. bakers) only.

3.0 RESULTS AND DISCUSSION

Table 1 shows the frequency of data observed in these locations. All respondents comprise both male and female. A total of 435 subjects were considered for each group, categorized as study group and control group. 40.23 % (175) of the respondent were from Agege, 20.68% (90) were from Osogbo while 39.08% (170) were from Ibadan.

Figure 1: A baker using PEFR

Figure 2: Mini-Wright peak flow meter

Figure 3: Weighing scale

Figure 4: Vernier calipers

The mean ages of the sampled bakers from Agege, Osogbo, and Ibadan were 36, 37 and 35 years respectively. In Agege, the minimum and maximum peak expiratory flow rate recorded was 175l/min and 523l/min, respectively, with a mean peak expiratory flow rate of 372.37l/min as illustrated in Table 2. Analysis of the questionnaire shows that 51.4 percent of bread bakers in Agege have only primary level of formal education. Over 70 percent said that they do not often experience sicknesses related to nose and throat, such as catarrh, running nose, cough, tightness of chest and wheezing, as well as sore eyes. In Osogbo, the minimum and maximum peak expiratory flow rate recorded was 220l/min and 478l/min, respectively, with a mean peak expiratory flow rate of 386.44l/min (Table 2). Also, at least 67.8 percent of bakers have formal education to the secondary level as shown in Table 3. An average of 77.8 percent said they do not have chest pain, while 67.8 percent said no to cough. Only 23.3 percent said they often have running nose, while only one (1) person representing 1.1 percent of the sample claim to have sore eyes from exposure to flour dust. Descriptive analysis of bakers observed in Ibadan was revealed that the minimum and maximum peak expiratory flow rate are 194l/min and 504l/min respectively, with a mean peak expiratory flow rate of 389.3l/min (Table 2). More so it was observed that 70.6 percent of bakers had primary level of education (Table 3).

Consequently, the bakers' responses to major health challenge on the job, shows that 50.3 percent of bakers' experience back pain, while 45.1 percent and 4.6 percent claim that their challenge in bread baking is fatigue and leg pain respectively. Also, Table 4 depicts the responses of the bakers from each geographical area on the awareness of prolong exposure to flour dust particles being detrimental to their health and use of protective equipment if provided. The responses obtained from Tables 4 shows that Ibadan bakers were more aware of the health detriments of exposure to flour dust while Agege bakers had the least. A comparison of bakers' responses on whether they will make use of protective equipment is made available for use is shown in Table 4. A comparison test was carried out using a T-test (independent sample T-test) assuming equal and unequal variances between the groups for each geographical location, and using an alpha (α) value of 0.05 as shown in Table 5. The decision making was based on the null hypotheses H0 says; there is no significant linear relationship between the independent variables and the dependent variable (i.e. PEFR). The results obtained show that p values are very less than 0.05. Hence we reject the null hypotheses and conclude that there is a significant linear relationship between the variables

Table 1: Total Frequency of observed data

Study Group	Number of bakers observed	Number of non-bakers observed
Agege, Lagos state	175	175
Osogbo, Osun state	90	90
Ibadan, Oyo state	170	170

Table 2: Statistics of Bakers in each State

Study Group	Parameter	Mean	Std. Error	Standard Deviation
Agege	PEFR (l/min)	372.37	3.73	49.29
	Height (cm)	163.13	0.46	6.15
	Weight (kg)	69.93	0.79	10.37
	Length of chest (cm)	45.64	0.31	4.05
	Years of exposure (year)	15.53	0.52	6.87
	Age (year)	36.14	0.50	6.57
Osogbo	PEFR (l/min)	386.44	5.53	52.42
	Height	158.90	1.18	11.20
	Weight	66.51	0.94	8.95
	Length of the chest	42.25	0.36	3.44
	Years of exposure (year)	13.920	0.60	5.65
	Age (year)	37.02	0.60	5.73
Ibadan	PEFR (l/min)	389.31	4.34	56.64
	Height	150.44	1.53	19.96
	Weight	69.18	0.57	7.46
	Length of the chest	45.37	0.34	4.40
	Years of exposure (year)	13.79	0.46	5.98
	Age (year)	35.02	0.48	6.31

***Table 3**: The level of Education of Bakers*

Level of Education	AGEGE Frequency	OSOGBO Frequency	IBADAN Frequency
NONE	47	-	7
PRIMARY	90	17	120
SECONDARY	33	61	43
ND/NCE	5	11	-
GRADUATE	-	1	-
Total	175	90	170

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The relationship between the PEFR and the independent variables were obtained using analysis of variance; thus, Equations 1 – 6 were modeled for the group in each location.

Table 6, 7, and 8 show the result of regression for Agege, Osogbo, and Ibadan between their bakers and non-bakers respectively.

From Table 6, the overall regression model for Agege bakers was given as:

$F(5,169) = 2.60$ and $P < 0.05$.

This shows that the regression model is significant, hence,

$$PEFR_{Agegebakers} = 636.58 - 0.95H + 0.24W - 1.99L - 0.58A - 0.81Y \quad (1)$$

For non-bakers in Agege,

$F(3,171) = 12.74$ and $P < 0.0001$.

The model is significant thus,

$$PEFR_{Agegenonbakers} = 261.63 - 1.05H - 0.16W + 9.02L + 2.41A \quad (2)$$

Table 4: Responses of Bakers to Awareness of the Health Detriments of Long Exposure to Flour Dust and the Use of Protective Equipment if Provided

	Response	AGEGE Frequency	OSOGBO Frequency	IBADAN Frequency
	Not sure	19	7	4
Awareness of the Health	Not at all	58	26	45
Detriments of Long	Some extent	68	37	78
Exposure to Flour Dust	Great extent	26	11	40
	Very great extent	4	9	3
	Total	175	90	170
	Not sure	4	7	2
Use of Protective	Not at all	13	10	17
Equipment if Provided	Some extent	51	54	65
	Great extent	4	18	78
	Very great extent	107	1	8
	Total	175	90	170

Table 5: Independent Sample T-Test (T-Test for Equality of Means) for all locations

		Degree of freedom	t- stat	t Critical	Sig.(2-tailed) p-value
Agege	EV	348	-15.135	1.966	0
	UEV	274	-15.065	1.968	0
Osogbo	EV	178	-10.323	1.973	0
	UEV	175	-10.323	1.973	0
Ibadan	EV	338	-12.066	1.873	0
	UEV	321	-12.066	1.873	0

*EV= Equal Variance Assumed, UEV=Unequal Variance Assumed

Table 6: ANOVA and Regression Results for Agege

	Bakers					Non Bakers				
	df	SS	MS	F	Sig. F	df	SS	MS	F	Sig. F
Regression	5	30202.24	6040.45	2.60	0.03	3	244739.90	81579.970	12.75	0
Residual	169	392536.62	2322.70			171	1094544	6400.841		
Total	174	422738.9				174	1339284			
	Coeff.	Stand. Error	t Stat	P-value		Coeff.	Stand. Error	t Stat	P-value	Sig. F

	Bakers					Non Bakers				
	df	SS	MS	F	Sig. F	df	SS	MS	F	Sig. F
Intercept	636.58	110.62	5.76	0.00		261.63	113.22	2.31	0.02	0.00
Height (cm)	-0.96	0.62	-1.55	0.02		-1.05	0.44	-2.41	0.02	
Weight (kg)	0.24	0.41	0.60	0.05		-0.17	0.91	-0.19	0.85	
Length of chest (cm)	-2.00	1.02	-1.96	0.07		9.03	1.47	6.14	0.00	
Age	-0.58	1.77	-0.33	0.00		2.42	0.37	6.54	0.04	
Years of Exposure	-0.81	1.70	-0.48	0.00		-	-	-	-	

Table 7: ANOVA and Regression Results for Osogbo

	Bakers					Non Bakers				
	df	SS	MS	F	Sig. F	df	SS	MS	F	Sig. F
Regression	5.00	19475.45	3895.09	1.45	0.21	3.00	23649.99	7883.33	2.27	0.09
Residual	84.00	225110.80	2679.89			86.00	299063.70	3477.49		
Total	89.00	244586.26				89.00	322713.70			
	Coeff.	Stand. Error	t Stat	P-value		Coeff.	Stand. Error	t Stat	P-value	Sig. F
Intercept	479.31	129.22	3.71	0.00		77.63	225.5	0.34	0.73	0.00
Height (cm)	-0.62	0.51	-1.21	0.00		1.25	1.33	0.94	0.35	
Weight (kg)	-0.86	0.90	-0.95	0.34		0.00	0.96	0.00	1.00	
Length of chest (cm)	5.15	2.47	2.09	0.40		4.70	2.12	2.22	0.20	
Age	-5.61	4.07	-1.38	0.01		4.36	1.40	3.11	0.00	
Years of Exposure	3.80	4.08	0.93	0.00		-	-	-	-	

Table 8: ANOVA and Regression Results for Ibadan

	Bakers					Non Bakers				
	df	SS	MS	F	Sig. F	df	SS	MS	F	Sig. F
Regression	5.00	64585.59	12917.12	4.44	0.00	3.00	93979.47	31326.49	6.75	0.00
Residual	164.00	477590.50	2912.14			165.00	765366.50	4638.59		
Total	169.00	542176.10				168.00	859346.00			
	Coeff.	Stand. Error	t Stat	P-value		Coeff.	Stand. Error	t Stat	P-value	
Intercept	443.38	113.68	3.90	0.00		364.22	95.83	3.80	0.00	
Height (cm)	-0.57	0.21	-2.73	0.01		-0.27	0.36	-0.75	0.03	
Weight (kg)	-1.15	0.56	-2.05	0.04		-1.21	0.73	-1.66	0.20	
Length of chest (cm)	2.08	0.96	2.18	0.30		5.40	1.33	4.06	0.07	
Age	1.88	4.45	0.58	0.03		1.32	0.31	4.26	0.01	
Years of Exposure	-3.51	4.58	-0.77	0.45		-	-			

The overall regression model for Osogbo bakers is significant, $F(5,84) = 1.45$ and $P < 0.05$.

$$PEFR_{Osogbobakers} = 479.31 - 0.62H - 0.85W + 5.15L - 5.60A + 3.79Y \quad (3)$$

The regression of Osogbo non-bakers is also not significant according to; $F(3,86) = 2.26$ and $P > 0.05$. Hence,

$$PEFR_{Osogbononbakers} = 77.63 - 1.25H - 0.003W + 4.70L + 4.35A \quad (4)$$

Also, the overall regression model for bakers and non-bakers in Ibadan is significant as follows;

$F(5,164) = 4.43$, $P << 0.01$:

$$PEFR_{Ibadanbakers} = 443.37 - 0.57H - 1.15W + 2.08L + 1.87A - 3.51Y \quad (5)$$

and $F(3,165) = 6.75$, $P << 0.001$

$$PEFR_{Ibadannonbakers} = 364.21 - 0.27H - 1.20W + 2.56L + 1.31A \quad (6)$$

where; A is the Age, H is the Height, L is the Length of chest, W is the Weight/ body mass, and Y is the number of year(s) of Exposure.

It was observed that the R squared (R^2) which is the amount of variance in the dependent variable that is accounted for by the independent variables, has values that are lesser than 0.95 confidence level. This is not unexpected, because not all data (independent variables) obtained is significant in predicting PEFR. However, this implies that while the year of exposure and age is significant, though other factors may contribute to low PEFR. In summary of the results obtained, Table 9 shows the significance of each variable as it is compared with the 3 locations. Table 10 in turn expresses the significance of bakers and non-bakers at each geographical location of the research.

Further analysis was carried out to check for variance in the PEFR of bakers who are in direct contact with flour dust and other bakers. Bakers in direct contact are mostly the personnel who mix the flour with other bread ingredients (who in most cases is also the dough miller) and those who offload newly purchased flours from the vehicle. The result of the T-test in Table 11 shows that there is a significant difference between the PEFR of bakers in direct contact with flour and bakers in non-direct contact with flour

Table 9: Comparison of the significance of each variable in the geographical areas

Parameter	Agege	Osogbo	Ibadan
Height	Significant	Significant	Significant
Weight	Not significant	Not significant	Not significant
Age	Significant	Significant	Significant
Length of Chest	Significant	Significant	Significant
Years of Exposure	Significant	Not significant	Significant

Table 10: Significance of equations of bakers and non-bakers in each location

Study Group	Bakers	Non-Bakers
Agege	Significant	Significant
Osogbo	Significant	Not significant
Ibadan	Significant	Significant

Table 11: Independent Sample T-test for Equality of means

	Bakers in direct contact	Bakers in non-direct contact
Mean PEFR	305.05	381.90
Variance	1980.12	2849.24
Observations	54	435
Df	73	
t Stat	-11.68	
P	2.17E-18	
t Critical	1.99	

4.0 CONCLUSIONS

Low PEFR in bakery workers can be accounted for as due to lackadaisical attitude to the use of personal protective equipment, while some bakers were not aware of personal protective equipment, hence are not inclined to the use. Low formal education and lack of routine health tips, as well as negligence to healthy subjects, are over nurtured among bakers, this poise a great factor to low PEFR and chances of pulmonary failure.

This study showed that bakers in direct contact with flour dust command a lower PEFR compared to bakers who are not in direct contact with flow dust. In contrast with Musa [18], this study also emphasized low reliance on the mathematical equations or models for each state of study due to low R squared value. Thus, suggesting that other factors may contribute to the low PEFR. Bakers are enjoined to seek medical care at intervals due to the often unavoidable exposure to flour dust.

The organized sector of government should enforce standard modus operandi for the unorganized unit of bakeries, either indirectly (through the union of bread bakers) or directly (by using government agencies) to supervise, inspect and ensure that bread bakers follow suite in protecting themselves from what may be termed as trivial.

4.1 Recommendation for Further Studies

Further study is encouraged on this subject to evaluate precisely the amount of flour dust particles inhaled by a baker over time of exposure and the amount of dust particles present in a given bakery.

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