



## Correlation between Body Mass Index and Peak Expiratory Flow Rate of an Indigenous Nigerian Population in the Niger Delta Region

Joffa Paul Kwaku Price<sup>1</sup> Nwafor Arthur<sup>2</sup> and Adienbo Ologhago Macstephen<sup>2</sup>

<sup>1</sup>Dept. of Physiology, Faculty of Basic Medical Sciences, College of Health Sciences, Niger Delta University, Wilberforce Island, NIGERIA

<sup>2</sup>Dept. of Human Physiology, Faculty of Basic Medical Sciences, College of Health Sciences, Port Harcourt, NIGERIA

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### Abstract

*This study establishes the relationship between peak expiratory flow rate (PEFR) and body mass index (BMI), in a representative sample of 1133 subjects in oil and gas exploitation and exploration environments in Epebu and Okodi in Izon communities, Bayelsa State, Nigeria, comprising 601 (or 53%) males and 532 (or 47%) females of comparable equal age. The mean PEFR value for the cohort was 367.47±106.67L/min while that for males were higher than that for females, and suggests that continuous and prolonged exposure to oil and gas production environment leads to diminution in peak expiratory flow rate. BMI for women fell within the spectrum of the normal adult body mass index cut off point, somewhere in between 20 - 22 kg/m<sup>2</sup> which represents the relatively small body frame of female adults. While BMI for males was suggestive that men are likely predisposed to developing overweight; their body mass fell within the pre-obese spectrum of 25 - 27 kg/m<sup>2</sup>. Our study indicates that weight gain in males might probably be attributed to the influence of genetic factors and environment on eating behaviour as well as sedentary activity; and that the inhabitants of Izon communities in the Niger Delta region of Nigeria may have respiratory and pulmonary disorders related to prolonged exposure to potentially dangerous chemicals from oil and gas flared in the environment.*

**Key words:** BMI, peak expiratory flow rate, Nigeria, Niger Delta.

### Introduction

Over the last four decades, environmental associated harmful toxic air pollution through venting and flaring wasteful "solution gas", global warming, climate change and extremes of temperatures had been a great concern in the Niger Delta Region of Nigeria, more specifically, Bayelsa State. Bayelsa state is the major oil and gas producing area and potentially dangerous chemicals<sup>1,2</sup> are being introduced into the environment all the time without desirable monitoring of the emission. More so, the effect of respirable suspended particulate matters and other noxious environmental hazards such as nitrogen dioxide, sulphur dioxide, and carbon monoxide on respiratory performance is also poorly understood<sup>3</sup>. The available data on the suspended particulate matters in air of the Niger Delta region as well as in other cities of Nigeria is scanty. Whether these changes are reflected in lung function and body mass changes of individuals was the subject of this study in the population of Nigerians in the Niger Delta region.

The primary aim of this study therefore was to establish the relationship between peak expiratory flow rate (PEFR)- the caliber of the airways which serves as valuable tool for diagnosis and treatment of lung functions<sup>4</sup> and body mass index (BMI) - a powerful tool for categorizing individuals weight and height in health and in disease for an indigenous Izon community in the Niger Delta region of Nigeria whose lifestyle and socio-economic factors might have been influenced

through oil and gas exploration and exploitation which is of clinical significance.

### Material and Methods

**Subjects and Study Area:** Peak expiratory flow rate (PEFR) and body mass index (BMI) for apparently healthy indigenous populations in Izon rural communities in oil exploitation and exploration environments -Epebu and Okodi in Bayelsa State, Nigeria comprising 1133 subjects 601 (or 53%) males and 532 (or 47%) females who had lived in the communities for more than half their lives were investigated. Epebu and Okodi districts are riverine villages in Ayama development area of Ogbia local Government area, about one and half hour drive by speed boat from the state capital, Yenagoa, Bayelsa state.

**Selection of Subjects:** The following criteria were required for acceptance as a 'normal' subject- No history of cardiopulmonary disease, capacity to co-operate adequately during the test, and no evidence or history of disease which might affect pulmonary function. Consent was sort voluntarily from each prospective participant by way of a request-for-consent/ questionnaire form, explaining the nature of the investigation to enable the participant to decide whether or not to participate in the study.

**Peak Exploratory Flow Rate Procedure:** The peak expiratory flow rate was determined as previously described<sup>4,5</sup>. Using Wright's peak flow meter. The subjects were asked to stand in

an upright position with the peak flow meter held horizontally in front of their mouth and allowed to take a deep breath in, and closed the lips firmly around the mouthpiece, making sure that no air leaks around the lips. The subject was asked to breathe out as hard and as fast as possible and the around the lips. The subject was asked to breathe out as hard and as fast as possible and the number indicated by the cursor was noted and the sequence was repeated twice more, thus obtaining three readings. The highest or best reading of all three measurements was taken as the peak flow rate.

**Body Mass Index (BMI) Determination:** The participants' height and weight were measured using standard clinic scales, their body mass index (BMI) was calculated from the relationship- body weight in Kilograms/ height in meters squared, where underweight was < 18.5 kg/m<sup>2</sup>, normal 18.5–24.9 kg/m<sup>2</sup>, overweight 25.0–29.9 kg/m<sup>2</sup> and obese ≥ 30.0 kg/m<sup>2</sup>.

**Data Analysis:** Statistical analysis was done using SPSS version 17.0 and Microsoft office excel 2007. Values were analyzed based on age, sex, BMI, and PEFR. The Z test was used to compare the mean for male and female at P < 0.05. The ANOVA was used to compare the various mean for the BMI group at P < 0.05.

## Results and Discussion

The mean age, PEFR and BMI values measured in a representative sample of 1133 subjects in oil exploitation and exploration environment in Bayelsa State, Nigeria, are presented in table-1. The mean PEFR value for the cohort was 367.47±106.67L/min while that for males were significantly higher (p<0.05) than that for females, table-1. Also, the percent mean difference was 7.74%. BMI values for males, shown in table-1 were higher than that for females making an overall mean difference in BMI of 2.79± 1.67 kg/m<sup>2</sup>; The males tend to be overweight while the females have a normal BMI values, as shown in table-1. Pearson correlation shows a significant negative correlation between age and PEFR for the overall population (r= -0.347, p<0.01; figure 1) for males (r= -0.405, p<0.1) and for females(r= -0.384, p<0.01).

Table 2 shows that PEFR values significantly declined with increasing age. Those in the age group 20 to 29 years had the highest values of PEFR while those in the age range >60years the lowest values. Further, tables-3 shows that there were

statistically significant variations in PEFR and BMI. From table-3, obese subjects, which represented 14% of the overall population, had higher PEFR values (374±11498 L/min) while those <18.5kg/m<sup>2</sup> had the lowest PEFR values (296±73.12 L/min which represented 3.5% of the population; While of the normal subjects (48%), with BMI 18.5 – 24.9kg/m<sup>2</sup>, had normal PEFR values. Correlation study shows positive relationship between PEFR and BMI for the overall population (r = 0.096, p<0.01, figure 2), for males (r = 0.158, p<0.01) and for females (r = 0.065, p<0.01).

The complex interplay in relation to changes in body mass index (BMI) and peak expiratory flow rate (PEFR) of individuals in the Niger Delta region in particular, Bayelsa State, Nigeria, as a result of the consequences of oil and gas production is poorly understood. PEFR measurements - the caliber of the airways are valuable tools in lung functions studies for diagnosis and treatment, and in epidemiological and occupational studies for identifying the presence of airflow limitation, assessing its severity and variation<sup>4</sup>; While BMI assessment is a powerful tool for categorizing individual's weight in health and in disease. To the best of our knowledge, this is the first study that measures body mass index (BMI) and Peak expiratory flow rate (PEFR) for the Izon communities in Bayelsa State, Nigeria which has been exposed to harmful toxic polluted air through long standing oil and gas exploration and exploitation in the past four decades. PEFR values for the overall population as well as for the both genders fell within the ranges for the general, normal adult Nigerian populations<sup>3,5-7</sup>. In reference to these studies it was observed that the mean PEFR value fell within the lower limits of ranges for normal adult Nigerians and that for the general African descents when compared with Caucasians<sup>8,9</sup>. A probable explanation for the cause of the diminution in PEFR might be a reflection of cumulative effect of environmental associated air pollution from oil and gas flared- induced climatic changes, high temperature and high humidity prevalence as well as sedentary lifestyle which negatively impacted on the respiratory function. Increased environmental pollution, lack of physical activities and comparatively low socioeconomic progress<sup>9</sup>, exposure to high ambient air temperature and high relative humidity<sup>10</sup> has been attributed to be some of the causes of reduced respiratory functions (PEFR). Adiposity- the pattern of fat distribution has also been suggested as a significant predictor of decreased PEFR<sup>11</sup>.

**Table-1**  
**Typical age, body mass index and peak flow expiratory rate values of the population,**  
*(Values are given as Mean ± Standard deviation, with range in parenthesis)*

Parameters	Male (n=601)	Female (n=532)	Significant difference Z – TES T (p value)
Age (yrs)	30.52 ± 11.79 (15 -89)	30.24 ± 13.50 (15 -80)	no
Peak expiratory flow rate (L/min)	408.78 ± 113.705 (130 – 670)	321.07 ± 77.83 (150 – 560)	yes (0.01)
Body Mass Index (kg/m <sup>2</sup> )	25.23 ± 4.07 (16.14 – 40.56)	22.44 ± 4.84 (16.22 – 42.87)	Yes ( 0.04)

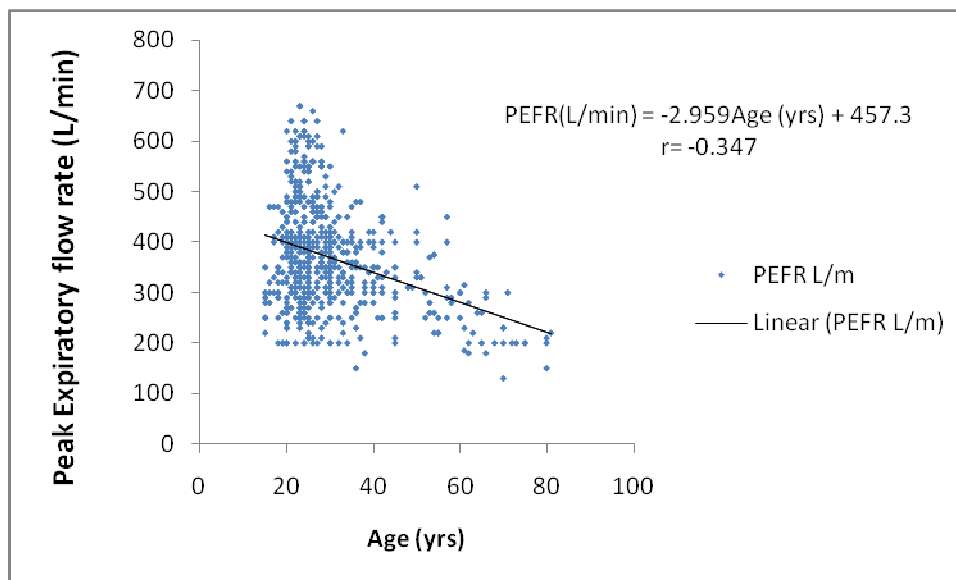


Figure-1

A scatter plot showing the relationship between age and peak flow expiratory rate of the population

Table-2

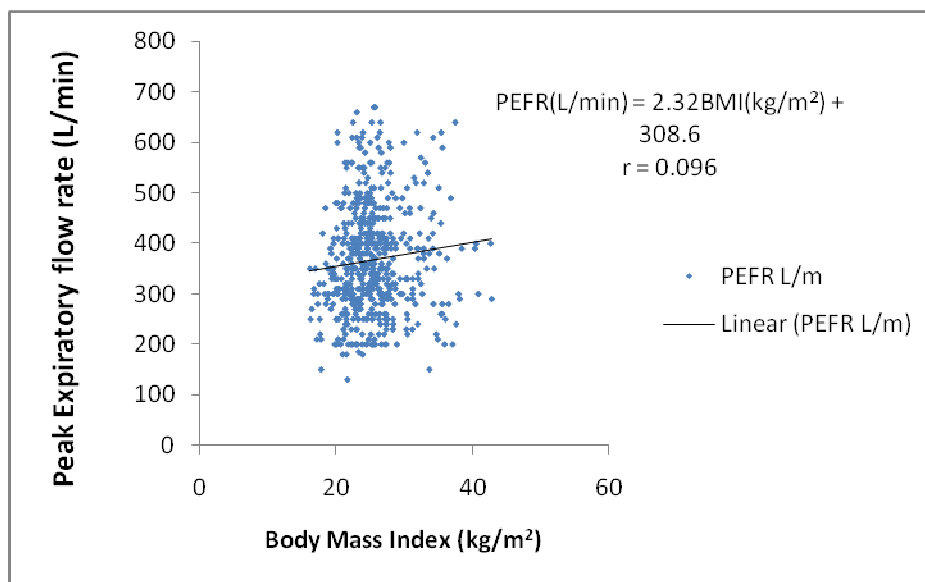
Categorization of subjects by body mass index and peak flow expiratory rate according to age groups (Values are given as Mean ± Standard deviation, with range in parenthesis)

Parameters	<20yrs	20 –29yrs	30 – 39yrs	40 – 49yrs	50 – 59yrs	≥60yrs	ANOVA P-value
Total Population : PEFR (L /min)	(n=84) 327.14 ± 5.39 (200 – 470)	(n= 634) 400.85±113.61 (200 – 670)	(n=225) 350.80± 9.45 (150 – 620)	(n=74) 331.89±64.22 (200 - 450)	(n=52) 319.62±74.74 (220 – 510)	(n=64) 229.69 ± 47.86 (130 – 315)	0.01
Male : PEFR (L/min)	(n=42) 353.33 ± 75.31 (200 – 470)	(n=324) 454.14±116.96 (200 – 670)	(n= 141) 377.30± 74.68 (200 – 620)	(n=36) 368.89±56.56 (200 - 450)	(n=34) 319.62±74.74 (250 – 450)	(n=24) 228.75 ± 56.65 (130 – 300)	0.01
Female : PEFR (L/min)	(n=42) 300.95 ± 66.54 (200 – 470)	(n=310) 345.16±77.80 (200 – 560)	(n=84) 305.24± 65.83 (150 – 480)	(n=38) 296.84±50.20 (200 - 400)	(n=18) 280.00±44.98 (220 – 340)	(n=40) 230.25±42.5 0 (150 – 310)	0.01
Total population : BMI (kg/m2)	22.09±3.23 (16.94 – 32.39)	25.32±4.44 (16.41 – 42.87)	26.38±4.24 (16.14 - 40.90)	26.15±4.36 (16.22 – 36.05)	27.12±3.78 (20.40 – 36.51)	23.73±4.72 (16.71 – 38.16)	0.01

Table-3

Depicts peak expiratory flow rate according to the international classification of body mass index

PARAMETER/ BMI Classification	<18.5kg/m <sup>2</sup> Under weight n=40	18.5 –24.9 kg/m <sup>2</sup> Normal weight n=548	25 – 29.9 kg/m <sup>2</sup> Over weight n= 386	>30 kg/m <sup>2</sup> obese n=159	ANOVA P-value
Entire Population PEFR (L/min)	296± 73.123 (150 – 470)	366.30±106.05 (130 – 660)	373.65± 107.46 (200 – 670)	374.47±114.98 (150 - 640)	0.02 yes
Males: PEFR (L/min)	285.00± 46.18 (210 – 350)	402.58 ±110.70 (130 – 660)	417.31± 111.06 (200 – 670)	434.65±125.95 (200 - 640)	0.02 yes
Females: PEFR (L/min)	303± 86.81 (150 – 470)	323.04±86.46 (180 – 560)	318.18 ± 71.29 (200 – 520)	325.91±76.84 (150 - 490)	0.58 No



**Figure-2**  
**Typical relationship between body mass index and peak flow expiratory rate for the entire population**

Further, there were statistically significant variations in PEFR and BMI with age. PEFR values significantly declined with increasing age consistent with previous studies<sup>11</sup>, which was largely attributed to the pattern of fat distribution in the body. Pearson correlation shows significant negative correlation between age and PEFR for the overall population and for both genders in contrast to the report<sup>3</sup> which was largely young school children aged 5years-14 years. Correlation study shows positive relationship between PEFR and BMI for the overall population and for the both genders in contrast to the studies in young Indian adults<sup>11</sup>. BMI for women fell within the spectrum of the normal adult body mass index cut off points, somewhere in between 20 - 22 kg/m<sup>2</sup> which correspondingly reflected the relatively small body frame of female adults and may also be associated with the lower PEFR results. While BMI values observed for males was suggestive that they are likely predisposed to developing overweight for their body mass fell within the pre-obese spectrum of 25 – 27 kg/m<sup>2</sup><sup>6</sup>; and probably may also explain the relatively large body frames for male adults. The findings however, contrasts the report that weight trends are more pronounced among African Americans with 60% of African American men and 78% of African American women identified as overweight. Accordingly, 28.8% of men and 50.8% of African American women are considered obese<sup>12</sup>. Similarly, the findings also contrasted the report that obesity prevalence was higher in females<sup>13</sup> but was consistent with high prevalence of overweight in males<sup>13</sup>. The observed BMI increase with age from the younger groups to 55-59.9 year group followed by decreased in age of the order of 60 years and above was in agreement with previous studies<sup>13</sup>. It has been suggested that body mass changes perhaps might probably be associated with genetic and environmental influences on eating and sedentary behaviours<sup>14,15</sup> which needed further studies.

Generally, our results are consistent with other studies that normal lung function values are varied according to age, gender, BMI differences in PEFR; and there are lung function variations between different ethnic groups<sup>8,13</sup>.

## Conclusion

In conclusion, our study indicates that the inhabitants of Izon communities in the Niger Delta region of Nigeria may likely be predisposed to developing respiratory and pulmonary disorders related to prolonged exposure to potentially dangerous chemicals from oil and gas flared in the environment. Weight gain observed in males might probably be attributed to the influence of genetic factors related environmental influence on eating behaviour and sedentary activity which needed further studies. Our findings may serve as a baseline reference value for medical purposes in Izon communities in particular, the Niger Delta region of Nigeria.

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