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Baseline Values of Pulmonary Function Indices in Port Harcourt, Rivers State, Nigeria

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Abstract

The lung and thus the respiratory system is often the most impacted organ in human exposures to air pollution. Consequently, the measurement of pulmonary function (lung capacities) is the widely used assessment procedure in morbidity and mortality studies. In field studies spirometry, which measure pulmonary function to determine Forced Expiratory Volume in one second (FEV_1), Forced Vital Capacity (FVC) and Peak Expiratory Flow Rate (PEFR), using a ventilometer is the preferred technique. In the Niger-Delta region where chronic gas flaring, in-door firewood cooking and vehicular emissions exacerbate rural and urban air pollution, baseline values of these lung capacities do not exist; thereby making the proper assessment of respiratory health risk most difficult. We have obtained these values in seven different areas of Port Harcourt, a Niger-Delta city in adult males and females by spirometry. The result show that generally, FEV_1, FVC and PEFR decrease with age in a biphasic pattern in both males and females but were higher in males than females. In males mean values of FEV_1 for 20-40 years old was 3.19 litres, FVC was 3.57, 3.58 litres and PEFR was 475, 523 L/min; for 41-50 years old, Mean values of FEV_1 was 3.07 litres, FVC was 3.48 litres and PEFR, 494 L/min; for 51-60 years old, Mean values of FEV_1 was 2.84 litres, FVC, 3.37 litres and PEFR, 492 L/min. In females, in 20-30 years old, Mean values of FEV_1 was 2.62 litres, FVC, 2.82 litres and PEFR, 404 L/min.; in 31-40 years old, Mean values of FEV_1 was 2.65 litres, FVC, 3.08 litres and PEFR, 455 L/min.; in 41-55 years old, Mean values of FEV_1 was 2.94 litres, FVC, 3.46 liters and PEFR, 468 L/min. The possible utility and implications of these results are discussed.

Keywords: Air pollution, Baseline, Pulmonary function indices, Spirometry

1.0 Introduction

Air pollution has become, since the caveman lit fire, a global problem and cause for public health concern. In urban cities, due primarily to high population densities, overcrowding, industrialization, vehicular and commercial emissions, air pollution has assumed extreme dimensions.

In Nigeria, especially the niger delta, in addition to all the familiar environmental consequences of under-development, the air pollution problem is exacerbated by off-shore and on-shore gas flaring in some locations around the city of Port Harcourt. This is in combination with extreme population congestion, unregulated crude home made commercial combustion machines, very high vehicular traffic and numerous personal generators that emit particulates(soot) and chronic health impact gases include, nitrogen dioxide, a respiratory irritant and constituent of gas-flares (see Ideriah *et al.* 2001;Oruambo & Okey 2006) which causes pulmonary edema, and on rare occasions, bronchiolitis obliterans, and the exposure to levels of 50ppm and above may result in fatal pulmonary edema with possible sub-acute or chronic lesions in the lungs (Procter and Hughes 1978), sulphur dioxide, a severe eye and respiratory irritant, acute exposure to which at concentrations of 10 to 50 ppm, is associated with reflex bronchoconstriction with increased pulmonary resistance (Procter and Hughes 1978) and particulates, the major effluent of gas flared which can absorb microbes and induce conjunctivitis and dermatitis, act synergistically with or potentiate the high toxic effects of other irritants such as sulphur dioxide (NG *et al.* 1993).

In other therefore to assess the toxicity of chronic obstructive pulmonary diseases (COPD) caused by human exposures to air pollution, or the respiratory health risks from such exposures, spirometric measurements of ventilatory (pulmonary) function b use of a ventilometer is recorded (NG *et al.* 1993) and the three important pulmonary function indices (PF1) or lung capacities/rate (LC) are: forced expiratory volume in one second (FEV1), forced vital capacity(FVC), and peak Expiratory Flow Rate, PEFR, (Asogwa 1986) values of which arev dependent on gender, age and height(NG *et al.* 1993).

Although normal baselie vales and the appropriate prediction equations have been worked out for Europe (Gregg and Nunn 1992) none have yet ben established in the Niger Delta region of Nigeria as extensive internet research shows no reference to such studies.

The baseline populations study reported here therefore provide the first set of baseline values of pulmonary function in the Niger Delta which may be useful in the proper assessment of respiratory health risk of human exposures to aural and urban air pollution episodes.

2.0 Material and methods

All persons used in this group were properly briefed on the aims of the study and voluntarily gave their informed consent. A total of 200 subjects were recruited. The study was conducted in the following areas, which aptly represented a cross-section of the city population:

1. Bundu Waterside, Port Harcourt, Rivers State
2. Rivers state University of Science and Technology, Port Harcourt, Rivers State
3. Aggrey Road Housing Estate, Port Harcourt, Rivers State
4. Ndoki Housing Estate, Borokiri, Port Harcourt, Rivers State
5. Presidential GRA/ Force Avenue, GRA, Port Harcourt, Rivers State
6. School of Health Technology, Mile 4, Rumeme, Port Harcourt, Rivers State
7. Chinda Housing Estate, Mile 3 Diodu, port Harcourt, Rivers State.

The procedures followed the protocols of Abramson's Survey Methods (Abramson 1974) and the world health Organisation Report (WHO 1989) Systematic sampling was applied with a sampling interval of 2 from the frame.

In the offices, every 2nd person was sampled. In the residential areas, every second household was sampled and all the adults in the household were recruited. The following exclusion criteria were applied:

1. People aged below 20 years and above 75 years
2. All smokers
3. All persons who are not normally resident in PH
4. All cases of known respiratory or cardiac diseases.

Instrument for measurement was the Clement Clarke Hand Held VM1/VMX Mini-wright/Mini-log Ventilometer and Peak Flow Meter.

Three blows were obtained from each subject. All blows considered technically unsatisfactory were discarded. Field investigators were intensively trained to ensure that the subjects performed the forced expiratory maneuvers properly.

Results are presented in Tables of Normal Baseline, "Gross" and "Summary", for males and females. Mean and Standard Deviations were calculated for each function.

3.0 Results

Out of the two hundred subjects studied, 187 (93.5%) produced satisfactory readings. In Table 1, the gross values of FEV1,FVC and PEFR (PEF) ofr males are represented as a function of age and height (in cm). The age and height ranges are between 20 years to 70 years; and 140cm to 185 cm respectively; however, because subjects between 66 and 70 years were unable in our study to produce reliable and consistent maneuvers, only data of the 20 to 60 years old age-range were computed. Similarly, because subjects between 140cm and 155cm height-range produced unreliable and inconsistent maneuvers, values obtained were discarded.

In Table 2, a summary of the data in Table 1 for each index is presented with the Means and Standard Deviations.

The results for female are also presented as Gross values in Table 3 and summary with Means and Standard Deviations for each index, in Table 4.

Table 1: Baseline Values of Pulmonary Function Indices or Lung Capacities obtained by Spirometry in male ranging in age from 20 to 70 years in Port Harcourt, Rivers State, Nigeria.

	Pulmonary Function Indices																													
Age	FEV_1 (litres)	FVC (litres)	PEF (L/min)	FEV_1	FVC	PEF	FEV_1	FVC	PEF	FEV_1	FVC	PEF	FEV_1	FVC	PEF	FEV_1	FVC	PEF	FEV_1	FVC	PEF	FEV_1	FVC	PEF	FEV_1	FVC	PEF	FEV_1	FVC	PEF
20-25yrs				2.23	2.23	328				3.98	4.24	521	2.55	2.76	484	3.55	3.89	577	3.62	3.91	607	3.58	3.94	525	3.52	4.22	525			
26-30yrs										2.93	3.13	480	2.33	2.58	455	3.08	3.50	493	3.64	4.01	545	3.66	4.44	639	2.87	3.54	431			
31-35yrs										2.49	3.18	388	2.77	3.25	532	2.93	3.38	488	3.35	3.76	553	2.53	2.58	550	3.92	4.26	535			
36-40yrs													3.68	3.91	570	2.99	3.28	467	2.90	3.12	493	4.10	4.86	568	3.43	3.95	612			
41-45yrs										3.01	3.66	485	3.37	3.77	529	3.29	3.65	520	2.82	3.31	469	3.25	3.69	497						
46-50yrs										2.70	2.89	472							3.59	4.27	460	2.50	2.58	520						
51-55yrs																2.90	3.30	541	2.35	2.89	441	2.93	3.37	413						
56-60yrs										2.86	3.57	538	3.10	3.69	531	2.89	3.41	488												
66-70yrs													3.58	3.76	567															

Table 2: Summary of Baseline Values of Pulmonary Function Indices in males as a function of Age Range with their Means and Standard Deviations

Age Range (years)	FEV_1 (litres)	FVC (litres)	PEFR (L/min)
	2.23	2.33	328
	3.98	4.24	521
	2.55	2.76	484
	3.55	3.89	577
	3.62	3.91	607
	3.58	3.94	525
20-30	3.52	4.22	525
	2.93	3.13	480
	2.33	2.58	455
	3.08	3.50	493
	3.64	4.01	545
	3.66	4.44	639
	2.87	3.54	431
	Mean X = 3.19	Mean X = 3.57	Mean X = 475
	St. Dev. = 0.57	St. Dev. = .69	St. Dev. = 87.14
	2.49	3.18	388
	2.77	3.25	532
	2.93	3.38	488
	3.35	3.76	553
	2.53	2.58	550
31-40	3.92	4.26	535
	3.68	3.91	570
	2.99	3.28	467
	2.90	3.12	493
	4.10	4.86	568
	3.43	3.95	612
	Mean X = 3.19	Mean X = 3.59	Mean X = 523
	St. Dev. = 0.54	St. Dev. = 0.63	St. Dev. = 61.2[illegible]
	3.01	3.66	485
	3.37	3.77	529
	3.29	3.65	520
	2.82	3.31	469
41-50	3.25	3.69	497
	2.70	2.89	472
	3.59	4.27	460
	2.50	2.58	520
	Mean X = 3.07	Mean X = 3.48	Mean X = 494
	St. Dev. = 0.37	St. Dev. = 0.53	St. Dev. = 26.54
	2.90	3.30	541
	2.35	2.89	441
	2.93	3.37	413
51-60	2.86	3.57	538
	3.10	3.69	531
	2.89	3.41	488
	Mean X = 2.84	Mean X = 3.37	Mean X = 492
	St. Dev. = 0.25	St. Dev. = 0.28	St. Dev. = 54.58

4.0 Discussion

The results generally followed a similar pattern across gender and age as was obtained in Europe (Gregg and Nunn 1992). In males, all three pulmonary function indices (PFI) or lung capacities (LC), FEV1, FVC and PEFR decreased with age, however, FEV1 Values decreased with age beyond 40 years, while FVC and PEFR values decreased with age beyond 50 years.

Table 3: Baseline Values of Pulmonary Function Indices or Lung Capacities obtained by Spirometry in females ranging in age from 20 to 55 years in Port Harcourt, Rivers State, Nigeria.

Height	140-145cm			146-150cm			151-155cm			156-160cm			161-165cm		
Age	FEV_1 (litres)	FVC (litres)	PEF (L/min)	FEV_1	FVC	PEF	FEV_1	FVC	PEF	FEV_1	FVC	PEF	FEV_1	FVC	PEF
20-25yrs	2.44	2.51	357				2.60	2.66	372	2.80	3.07	404	2.52	2.76	435
26-30yrs				2.15	2.37	293							2.50	2.75	384
31-35yrs							2.39	2.70	426	2.20	2.66	373	2.68	3.04	441
36-40yrs													2.78	3.18	556
41-45yrs							2.49	2.92	459						
46-50yrs													3.65	4.20	427
51-55yrs										2.86	3.67	513	2.48	2.81	448

Height	166-170cm			171-175cm			176-180cm			181-185cm			186-190cm		
Age	FEV_1	FVC	PEF	FEV_1	FVC	PEF	FEV_1	FVC	PEF	FEV_1	FVC	PEF	FEV_1	FVC	PEF
20-25yrs	2.60	2.92	451	3.27	3.61	489									
26-30yrs	2.70	2.70	434												
31-35yrs	2.58	2.93	471							3.85	4.53	501			
36-40yrs				2.11	2.50	419									
41-45yrs															
46-50yrs	2.86	3.24	516												
51-55yrs	3.50	4.08	454	2.69	3.32	456									

Pulmonary Function Indices

Table 4: Summary of Baseline Values of Pulmonary Function Indices in females as a function of Age Range with their Means and Standard Deviations

Age Range (years)	FEV_1 (litres)	FVC (litres)	PEFR (L/min)
	2.44	2.51	357
	2.60	2.66	372
	2.80	3.07	404
	2.52	2.76	435
	2.60	2.92	451
20-30	3.27	3.61	489
	2.15	2.37	293
	2.50	2.75	384
	2.70	2.70	434
	Mean X = 2.62	Mean X = 2.82	Mean X = 404
	St. Dev. = 0.30	St. Dev. = 0.36	St. Dev. = 58.33
	2.39	2.70	426
	2.20	2.66	373
	2.68	3.04	441
	2.58	2.93	471
31-40	3.85	4.53	501
	2.78	3.18	556
	2.11	2.50	419
	Mean X = 2.65	Mean X = 3.08	Mean X = 455
	St. Dev. = 0.58	St. Dev. = 0.68	St. Dev. = 60.04
	2.49	2.92	459
	3.65	4.20	427
	2.86	3.24	516
41-55	2.86	3.67	513
	2.48	4.08	448
	3.50	3.32	456
	Mean X = 2.94	Mean X = 3.46	Mean X = 468
	St. Dev. = 0.51	St. Dev. = 0.60	St. Dev. = 37.72

For instance FEV_1 of 20-30 years age range was unchanged when compared to that of 31-40 years age range at means of 3.19 litres against 3.19 litres, respectively, but decreased significantly between 41-50 years and 51-60 years age ranges (means of 3.07 litres and 2.84 litres, respectively). Mean values of FVC and PEFR were near equivalent between 20 and 40 years age range, but decreased slightly between the 40 and 60 age range.

We suspect this biphasic pattern of age related decreases in the values of FEV_1 , FEV and PEFR to be due perhaps to our biology and environment, or that mwny subjects were unable to consistently empty their lungs properly in the three blows required.

This may explain why mean FVC and PEFR values for a 25year old of 3.57 litre and 475L/min respectively were equivalent to those for an equally healthy 50 year old or 60yrar old0f 3.48 litres and 494 L/min or 3.37litres and 492L/min respectively. Whereas FEV_1 mean value for the same 25 year was 3.19, it was lower than 3.07 litres and 2.82 litres for the 50 years old years old respectively.

In females, the mean value form all three in dices were predictably lower than those of males in all ages and height ranges, which is consistent with European trend (Gregg and Nunn, 1992).

When compared to European vales however, all three indices in both males and females in our study were much lower. For instance, a healthy 40 year old man who is 175 cm tall in our study had a mean FEV1 value of 3.19 litres, an FEV of 3.59 litres and PEFR of 523L/min, whereas his European counterparts predicted values for his age and height are vFEV1 of 4.09 litres, FVC of 5.02litres and PEFR of 636L/min (Gregg and Nunn, 1992).

The same is not true for the females in our study however, who faired much better against their European counterpart; a healthy 40 year old female who is 160 cm in height, in our study, a mean FEV_1 value of 2.65 litres, FEV of 3.08 litres and PEFR of 455 L/min (Greegg and Nunn, 1992)- the differences are marginal. This gender differences between males and females in our study relative to European counterparts may attributable in activity pattern in our society coupled with biological differences. More importantly, however, is that the large differences between our values and European values may reflect the poor air quality level in Port Harcourt.

PFI and LC values are useful tolls for prediction of the on set of respiratory disease(s) because they collectively measure the extend of air ways obstruction, which may lead to any one of the pulmonary obstruction d diseases such as asthma, emphysema, bronchitis, and even cancers, especially under harsh air pollution episodes and prolonged of repeated human exposures (NG *et al*. 1993).

However without base line vales of PFI, it becomes exceedingly difficult to assess the potential for the on set of respiratory diseases in a population that may be exposed chronically to air pollution episodes, such as in a moderately elevated in door and out door particulates concentration derived from cooking methods and high vehicular and/or gas-flare emissions (Oruambo and Okey, 2006).

We suggest therefore that these PFI baseline values can be a useful guide in the assessment of respiratory health risk of population exposures to rural and urban air pollution here in the Niger Delta.

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