ISSN (Print): 2476-8316
ISSN (Online): 2635-3490
Dutse Journal of Pure and Applied Sciences (DUJOPAS), *Vol. 4 No. 2 December 2018*

Assessment of Cardiopulmonary Function and Respiratory Symptoms among Petrol Pump Attendants in Kano Metropolis

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Abstract
The increase in automobiles in cities causes an increase demand for petroleum and a corresponding increase in vehicular-exhaust related air pollution. During vehicle refueling, a petrol-vapour-saturated air is expelled from the automobile petrol tanks into the breathing zone of petrol pump attendants (PPAs), hence, putting them at increasing risk of inhaling both petroleum and vehicular-exhaust related volatile organic compounds which have been reported to cause disturbances in respiratory functions. Despite this, there is a dearth of information defining the cardiopulmonary health of petrol pump attendants. This study was therefore designed to assess the cardiopulmonary function of 56 petrol pump attendants who were matched for age, sex and ethnicity with 59 bank employees as controls. FVC, FEV_1, Tiffeneau-Pinelli Index and PEF were assessed using Spirometry, while SPO_2, PR, SBP, DBP and MAP were measured using pulse oxymeter and sphygmomanometer respectively. An independent sample t-test was used to compare means at 5% a-level of significance. The results indicate that the cardiovascular parameters of PPAs are not significantly different from those of the controls. However, as compared to controls, the PPAs had significantly lower values of FVC (5.66L Vs 3.77L), FEV_1 (5.10L Vs 2.93L), PEF (6.43L Vs 4.10L), Tiffeneau-Pinelli index (90.6% Vs 78.6%) and a significant hypoxaemia (97.12% Vs 95.36%). Further, PPAs who smoke were found to have a significantly lower FVC and FEV_1 compared to the non smokers. In addition, PPAs taking more than five shifts a week had significantly lower FVC, FEV_1 and SPO_2 compared to those taking five or less shifts a week. In conclusion, the findings of this study indicates that petrol pump attendants had reduced pulmonary function parameters and hypoxaemia-putting them at increasing risk of a mixed airway dysfunction-but, are likely not at increasing risk of allostatic implications of higher blood pressure. In consequent, lunching of awareness campaign on the adverse health effects of petroleum and the enforcement of regulations for the use of protective gadgets could go a long way in reducing the health hazards of petroleum exposure.

Keywords: Petrol pump attendants, Petroleum vapour, Cardiopulmonary function, Hypoxaemia.

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INTRODUCTION

The increasing number of automobiles complicating urban life put a corresponding increase in demand for petroleum needed for fueling (Aprajita *et al*, 2011). The non-self-servicing policy of petrol dispensing in Nigeria necessitate the employment of petrol pump attendants at filling stations. During refueling of an empty or near empty petrol tank, a petrol-vapor-saturated (dead space) air is expelled through the filling channel around the nozzle into the breathing zone of petrol pump attendants (PPAs). The volume of this dead space air is proportionately equal to the volume of petrol dispensed (Udonwa *et al*, 2009). Alarmingly, this generate as high a concentration of VOCs as 20 to 200 parts per million (ppm) in the breathing zone of the PPAs which is far above the recommended 1 ppm for an 8-hour work day weighted average exposure (Odewabi *et al*, 2014). This cycle of exposure is repeated as many times as the attendant fills a tank, hence, may create a proportionate linear relationship between; number of vehicles refueled per shift, hours spent on each shift or number of shifts undertaken per week, and the intensity of exposure to the petrol fumes. The PPAs are therefore under constant exposure to petroleum vapour whose composition includes 95% acyclic and 2% aromatic compounds which are considered the most hazardous components (Begum & Rathna, 2012). In addition, the vehicles emit automobile exhausts which pollute the breathing zone even further, putting the petrol pump attendants at an increasing risk of inhaling both respirable and non respirable air pollutants hence putting their general health at stake.

Petroleum exposure have been implicated in many systemic dysfunctions including prompting tissue non-specific free radicals attack and chronic inflammation by increasing the generation of reactive oxygen species (ROS) and decreasing the body's antioxidant defense system (Odewabi, *et al.*, 2014). It has also been reported to cause skin irritations (Chauhan*et al.*, 2014), cardiovascular dysfunctions (Chilcott, 2007), increased BMI, decreased TSH levels (Uzma *et al.*, 2008), aggravation of renal damage (Qin *et al*, 2012, Ravnskov, 2005, Brautbar, 2004, Hussain et al, 2013, Nwanjo and Ojiako, 2007), respiratory symptoms (Chilcott, 2007; Adeniyi *et al*, 2014; Chauhan *et al*, 2014), as well as impairment in respiratory function (Singhal *et al*, 2007; Uzma *et al*, 2008; Aprajita *et al*, 2011; Adeniyi *et al*, 2013; Bhide *et al*, 2014).

As respiratory impairments can affect the function of cardiovascular system, information regarding the effects of petroleum exposure on cardiopulmonary function is important; however this information is dearth in the literatures of PPAs' occupational health hazards. In view of the above this study therefore aimed to assess systolic blood pressure (SBP), diastolic blood pressure (SBP), pulse pressure (PP), mean arterial blood pressure (MAP), pulse rate (PR), peripheral capillary blood oxygen saturation (SPO_2), forced vital capacity (FVC), forced expiratory volume in the first second (FEV_1), Tiffeneau-Pinelli index (FEV_1/FVC), peak expiratory flow (PEF), as well as the prevalence of exposure-related respiratory symptoms among petrol pump attendants in metropolitan Kano.

MATERIALS AND METHODS

This analytic retrospective cohort study was conducted in Kano metropolis using a systematic sampling technique. Kano metropolis is the capital of Kano state and the commercial hub of Northern-Nigeria. It is located between latitude 11º59' and 12º02' N and longitude 8º33' and 8º40' E with a dominant Hausa-Fulani tribe whose major occupations are trading, civil service and farming (Ibrahim *et al.*, 2018). Fifty six (56) petrol pump attendants (PPAs) were recruited and matched for age, sex, weight and height with 59 controls pooled from bank employees. Ethical approval for the study was granted by the research and ethics committee of Kano State Ministry of Health (Ref: MOH/Qff/797/T.I./39). Each participant was given a detailed explanation of the context, including the protocols, of the research before a signed informed consent was sought and obtained.

Brief medical history and general physical examination were conducted on each of the recruited participant in an office or lobby within their respective filling stations or banks. Those who were less than 18 or more than 40 years old, those who spent less than one year as pump attendants and those who were found to have an eventful medical history or physical examination findings were excluded for the study. Thereafter, Spirometry was conducted according to the protocols described by Pellegrino *et al*. (2005) using a DATOSPIR 120 Spirometer (SIBEL S. A. Rossello, 500 08026 BCN Spain). Weighing scale and stadiometer were used to respectively obtain weight and height of the subjects while a modified version of the medical research council's questionnaire was used to assess their respiratory symptoms. Using the questionnaire, information regarding sociodemography, educational background, employment, smoking and past medical histories as well as their respiratory health symptoms were obtained.

Statistical Package for Social Sciences (SPSS) version 20.0 was used for statistical analysis. Quantitative data were summarized using mean ± standard deviation, while qualitative variables were summarized using absolute counts and percentages. An independent samples t-test was used to compare means of quantitative variables while Pearson's chi-square/Fisher's exact test (where appropriate) was used to compare categorical variables between the groups, data presentation was done in tables, and, in all cases, $P \leq 0.05$ was considered as statistically significant.

RESULTS AND DISCUSSION

The SBP, DBP and MAP of the subjects and the controls appear statistically similar and the mean value of all the parameters fall within the acceptable limits of normal (Table 1).

Table 1: Cardiovascular Parameters of the Respondents (Mean±SD)

Variables	Controls	PPAs	t- value	p-Value
Systolic blood pressure (SBP)	127±16	130±14	-1.19	P=0.24
Diastolic blood pressure (DBP)	71±13	74±10	-1.34	P=0.18
Mean arterial pressure (MAP)	90±12	92±10	-1.20	P=0.23
Pulse rate (PR)	78±13	75±12	1.18	P=0.24

The results also show that the FVC, FEV_1, PEF, Tiffeneau-Pinelli index and the peripheral capillary blood oxygen saturation of PPAs is significantly lower than that of the controls, pointing to poor oxygenation of blood and adverse lung function affectation with both restrictive and obstructive picture (Table 2).

When the influence of duration of employment as PPA, number of shifts taken per week and the average hours spent on a shift were explored, a statistically significant decline in FVC and

SPO_2 of the PPAs were observed among those who take more than five shifts per week (Table 3). This is indicative that frequency of exposure could be more important, as a factor, in causing pulmonary damage than the length and duration of exposure to the petrol fumes (Tables 4 & 5), thus putting those with more frequent exposure at increasing risk of restrictive lung pathology. Alarmingly, almost a quarter of the PPAs smokes cigarette. In addition, when the pulmonary function parameters of the PPAs were compared between smokers and non-smokers, a statistically significant decrease in FVC, FEV_1 and PEF were noted among the smokers (Table 6) demonstrating that cigarette smoking among the PPAs may have an additive adverse obstructive effect on their airways.

In addition, when the prevalence of exposure-related respiratory symptoms among the petrol pump attendants was explored, it was found that the PPAs had a significantly higher prevalence of all the respiratory symptoms assessed as compared to the controls (Table 7).

Measurement of how much and how fast air can be inhaled or exhaled in quiet and forced breathing allows a better understanding of lung function both in physiological and pathological conditions (Al-Ashkar *et al.,* 2003; Ebomoyi and Iyawe, 2005; Liou and Kanner, 2009). The findings of this study have demonstrated a decrease in forced vital capacity, forced expiratory volume in the first second, peak expiratory flow and the Tiffeneau-Pinelli index which are all dynamic lung function parameters whose values depend on static volumes (Liou and Kanner, 2009).

These abnormal findings could be, perhaps, because the PPAs are in constant exposure to petroleum vapour whose inhalation is reported to cause widespread peroxidative processes, decreases antioxidant defense system and induces oxidative stress which results to non-specific free radical attacks and inflammatory responses (Odewabi *et al.,* 2014). These effects of oxidative stress and chronic inflammation may also alter the concentration and properties of pulmonary surfactant as well as the fibromuscular layers of the airways which may contribute to early closure of smaller airways, reduction in mid-expiratory flow rate and other characteristics of peripheral airway obstruction (Uzma *et al.* 2008). Consequently, decreased static and dynamic lung volumes occur, causing reduced pulmonary ventilation and poor blood oxygenation.

In contrast to the findings of mixed airway abnormality from this study, Singhal *et al*. (2007), reported a significant reduction of PEFR and FEFR (25-75), FVC and FEV1 but not their Tiffeneau-Pinelli index, indicative of restrictive airway abnormality. This restrictive pattern of airways abnormality were similarly reported by Begum and Rathna (2012), Aprajita *et al*., (2011) as well as Uzma *et al.* (2008), who observed a restrictive picture that changed to a mixed pattern after 10 years of employment as fuel pump attendant. On the other hand, the findings of this study are in keeping with those of Bhide *et al*. (2014), who reported that all the lung function parameters studied were decreased in petrol pump workers when compared to controls. Similar observations were also reported by Adeniyi *et al.,* 2013; Adeniyi, 2014.

From this study, an additional adverse outcome on FVC was observed as a result of undertaken 5 or more shifts per week. This is contrary to the findings of Uzma *et al.* (2008) who observed that restrictive or peripheral airway obstruction appeared during the early period of exposure (1–10 years) but is changed to a mixed pattern following prolonged exposures (>10 years). This observation was similarly reported by Aprajita *et al*., (2011**)** and Sushil *et al.,* (2013). Uzma *et al.* (2008) and Aprajita *et al*. (2011), however did not assess the frequency of shifts taken nor did they assess hours spent during each shift as independent variables for determining the adverse outcomes of petroleum exposure among the petroleum pump attendants, but have effectively reiterates the progressive nature of impairments in a dose or time dependent manner. It could also be observed form this study that cigarette smoking among the PPAs presents an additive adverse obstructive effect on their airways. Perhaps, this may be because of an independent adverse effect of cigarette smoking on the respiratory system which has been reported to cause poor lung development in adolescents as well as airway obstruction (Gold *et al*., 1996; Anthonisen *et al.*, 2002).

Also, the findings of high prevalence of respiratory symptoms among the PPAs is in keeping with the findings of Chauhan *et al*. (2014) and Adeniyi *et al*. (2014) among petrol exposed individuals. The presence of respiratory symptoms may be due to the high level of benzene and other low molecular mass volatile organic compounds found around their breathing zone which irritates the airways (Chilcott, 2007). In addition, the PPAs are also exposed to automobile exhaust and ambient roadside pollution which also irritates the airways and cause significant respiratory morbidity (Schwela, 2000; Nku *et al*. 2005; Efe, 2008; Jones *et al*. 2008; Ibrahim, 2014).

Table 2: Pulmonary Function Parameters of Subjects and Controls (Mean±SD)

Variables	**Controls**	**PPAs**	**t-value**	**p-value**
FVC	5.66±1.11	3.77±1.34	8.24	0.001*
FEV_1	5.10±1.14	2.93±1.20	9.93	0.001*
FEV_1/FVC (%)	90.6±13.70	78.60±16.81	4.20	0.001*
PEF	6.43±1.71	4.10±1.84	7.07	0.001*
SPO_2 (%)	97.12±1.94	95.36±2.28	5.47	0.001*

*significant at P ≤ 0.001

Table 3:Pulmonary Function Parameters of PPAs and Shifts Undertaken Per Week (Mean±SEM)

Variables	≤ 5 shifts per week (n=11)	>5 shifts per week (n=45)	t-value	p-value
FVC	4.59±1.72	3.57±1170	2.331	0.024*
FEV_1	3.48±1.43	2.79±1.11	1.751	0.086
FEV_1/FVC (%)	78.21±16.52	78.67±17.07	-0.081	0.935
PEF	4.16±1.75	3.83±1.88	0.520	0.605
SPO_2(%)	95.73±1.86	93.82±3.19	2.623	0.011*

*significant at P ≤ 0.05

Table 4: Pulmonary Function Parameters of PPAs and Duration of Employment (Mean±SEM

Variables	**1-5 years of employment (n=13)**	**>5 years of employment (n=43)**	**t-value**	**p-value**
FVC	4.15±1.10	3.66±1.40	1.16	0.253
FEV_1	3.41±1.00	2.78±1.23	1.66	0.102
FEV_1/FVC (%)	82.48±13.59	77.41±17.64	0.95	0.345
PEF	4.10±1.70	4.10±1.90	-0.01	0.992
SPO_2(%)	95.60±1.84	94.54±3.33	1.49	0.142

Table 5: Pulmonary Function Parameters of PPAs and Hours Spent Per Shift (Mean±SEM).

Variables	Spends ≤8 hours per shift	Spends >8 hours per shift	t-value	p-value
FVC	3.79±1.13	3.74±1.78	0.126	0.900
FEV_1	2.95±1.10	2.88±1.48	0.209	0.836
FEV_1/FVC (%)	78.60±13.76	78.55±18.15	0.009	0.993
PEF	4.24±1.86	3.76±1.81	0.904	0.370
SPO_2(%)	95.49±1.95	95.06±2.97	0.642	0.524

Table 6: Pulmonary Function Parameters of PPAs and Their Smoking Habits (Mean±SEM)

Variables	Non Smokers (n=43)	Smokers (n-13)	t-value	p-value
FVC	4.05±1.06	3.14±1.70	2.453	0.017*
FEV_1	3.26±1.03	2.16±1.24	3.452	0.001*
FEV_1/FVC(%)	80.99±15.62	73.05±18.60	1.651	0.105
PEF	4.47±1.87	3.22±1.49	2.444	0.018*
SPO_2(%)	95.41±1.97	95.33±2.43	0.117	0.907

Table 7: Table of Chi-Square ($χ^2$) for Respiratory Symptoms among Respondents

Variables	Controls	PPAs	$χ^2$- Value	P-Value
Cough				
O(E)	0 (8.2)	16 (7.8)	19.582	0.000
SR	-2.9	2.9		
Dyspnoea				
O(E)	0 (7.2)	14 (6.8)	16.795	0.000
SR	-2.7	2.8		
Wheezing				
O(E)	0 (5.1)	10 (4.9)	11.539	0.000
SR	-2.3	2.3		
Sneezing				
O(E)	6 (20)	33 (19.0)	30.477	0.000
SR	-3.1	3.2		
Runny nose				
O(E)	2 (10.3)	18 (9.7)	16.533	0.000
SR	2.6	2.6		
Eye irritation				
O(E)	8 (19.0)	29 (18)	19.238	0.000
SR	-2.5	2.6		

O=observed counts/frequencies, E=expected counts/frequencies, SR=standardized residual

CONCLUSION

This study has found a decreased lung volume (FVC) and the rate at which air ventilates the respiratory system of PPAs (PEF and FEV_1). It also unveiled associated systemic consequences of hypoxaemia and higher prevalence of respiratory symptoms, demonstrating that exposure to petroleum among the PPAs is associated with a compromise in lung function, poor blood oxygenation and an accentuation of respiratory symptoms in an intensity dependent manner. In contrast to these pulmonary findings, no significant effect on the assessed cardiovascular parameters was observed.

RECOMMENDATIONS

Based on the findings of this study, it is recommended that awareness campaign on the adverse health effects of petroleum exposure should be lunched both at stakeholders as well as at the general public levels. The relevant regulatory agencies should advocate and enforce the use of protective gadgets such as foot wears (boots), hand gloves and safety face masks among petroleum products handling personnel. Pre-employment and regular/periodic medical checkups need to be introduced among PPAs such that those identified to be at risk would be referred to receive prompt and proper medical attention and also to have a change in work type or work schedule.

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