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Association between exposure to fuel and respiratory health among fuel attendants in Ndola, Zambia

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ABSTRACT

Aim: To determine association between exposure to fuel and respiratory health (lung function) among fuel attendants in Ndola, Zambia. **Materials and Methods:** a cross-sectional comparative study was done with the exposed group being the fuel attendants and the non-exposed group being medical students. A questionnaire was administered, weight and height measured and lastly spirometry done on each person who consented. **Results:** A Total of 69 exposed persons and 121 non-exposed persons participated in the survey. Overall, 120 (63.2%) participants were males and 43.7% were aged <25 years. Overall, 7.4% of respondents smoked and 42.1% drunk alcohol. Exposed participants tended to have lower BMI than non-exposed participants (p= 0.004). The prevalence of lung function impairment among the exposed was 29.0% and 7.4% among the non-exposed (p<0.001). There was a significant reduction in the lung function parameters FEV1, FVC and PEF among the exposed group compared with the non-exposed group (p values 0.004, 0.010 and 0.031, respectively). Adjusting for BMI, exposed participants were 2.18 (95% CI, 1.39, 3.42) times more likely to have lung function impairment compared to the unexposed group. **Conclusion:** Fuel attendants were at risk of lung function impairment. Thus it is pertinent that they are provided with masks to protect them from constantly inhaling the fuel fumes and also medical check-ups be provided before and during their period of work.

Keywords: FCV, FEV, PEF, Fuel attendants, Lung function impairment, Zambia.

Introduction

Petrol is a mixture of volatile hydrocarbons, while diesel fuel contains paraffin's, alkenes and aromatics [1]. Petrol and diesel are the most commonly used automobile fuels in Zambia. A long term exposure to the air pollutants may lead to ill health on the respiratory functions [2]. Petrol attendants exposed to benzene, lead and carbon monoxide may suffer adverse health effects [3].An association between fuel exposures among fuel attendants with impairment in lung function has been observed before. It has also been observed that there is increased susceptibility to lung infection in fuel attendants compared to the controls [4,5]. Exposure to benzene in petrol has shown to also affect the normal functioning of the body systems including the respiratory system. Studies have shown that Benzene is an exaggerating cause for lung function derangements in petrol pump workers as its content in petrol is in the range 1-5% [6, 7]. It has also been reported that petrol pump workers are vulnerable to develop restrictive lung disease especially those who are involved in the occupation for long duration of more than 5 years [8]. In addition to this, petrol-pump workers who are exposed to the petrol fumes may exhibit a number of clinical signs and symptoms which may be due to benzene toxicity. However, these clinical signs may arise after a long time, as respiratory diseases may take long to give signs. Furthermore, Bamidele *et al* [9] have shown that petrol attendants exposed to petrol fumes appear to have lower vital capacity and possibly increased susceptibility to upper respiratory tract infections when compared with controls. There is need to assess medical challenges of fuel attendants, one of which is respiratory ailments. Although studies have been done about the subject

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globally, none have been done in Zambia. This study aims to address this gap. Thus the aim of this study is to determine association between exposure to fuel and respiratory health (lung function) among fuel attendants in Ndola, Zambia.

Materials and methods

Study area

Ndola is a town in Zambia's Copperbelt province and it consists of 455,194 people (2010 census). There are 29 filling stations in the city. Ndola is also the commercial capital city of Zambia because it is the industrial and commercial centre of the Copperbelt province. It is also host to a newly opened Copperbelt University School of Medicine as of 2011 at Ndola Central Hospital.

Study population

The study population comprised of an exposed group which were the fuel pump attendants and the non-exposed group which were the medical students of the Copperbelt University School of Medicine as controls.

Study Design

The study design was a cross-sectional comparative study.

Measurements

Questionnaire

A questionnaire was administered to each participant to obtain information on social demographic characteristics, respiratory conditions and symptoms as well as any smoking and alcohol habits. Participants who needed assistance concerning the completion of the questionnaire were assisted as required. Some participants thought it would be much faster if someone else asked the questions unlike answering it on their own. The questionnaire was first answered then weight and height of the participants were measured.

Spirometry

Spirometry is a pulmonary function test that was carried out using a Portable spirometer Spirobank G (Medical International Research). The Spirobank G user manual was used as a guide to operating the spirometer. The spirometer was calibrated to suit each participant's sex, age, height and weight. The participant was then comfortably put in an upright position and consequently taken through the manoeuvre required which was full inspiration then forced expiration into the spirometer. The manoeuvre was done with the nose clip in place to ensure accuracy of results. The Test was repeated three times and the best result was considered for analysis. The parameters measured by the apparatus were the Forced vital capacity (FVC), Forced Expiratory Volume in one second (FEVI), FEVI /FVC ratio and Peak Expiratory Flow Rate (PEFR).

Statistical analysis

Univariate and bivariate analyses were carried out using Epi info version 3.5.1. In addition to this, a multivariate logistic regression analysis was conducted using Statistical Package for Social Sciences (SPSS) version 16.0. Frequencies were tabulated and the same was done for the means and standard deviation. The Yates' corrected Chi-square test was used to determine associations between factors. A resulting yielding a p value of less than 5% was considered statistically significant.

Results

There were 69 petrol attendants and 121 medical students who participated in the study. The response rate for the petrol attendants was about 69% as for the students it was 60.5%. The distributions of age, working experience and body mass index were similar between males and females.About half (56.5%) of the exposed participants worked for less than 1 year (Table 1).

Table 1: Factor occurrence among males and females

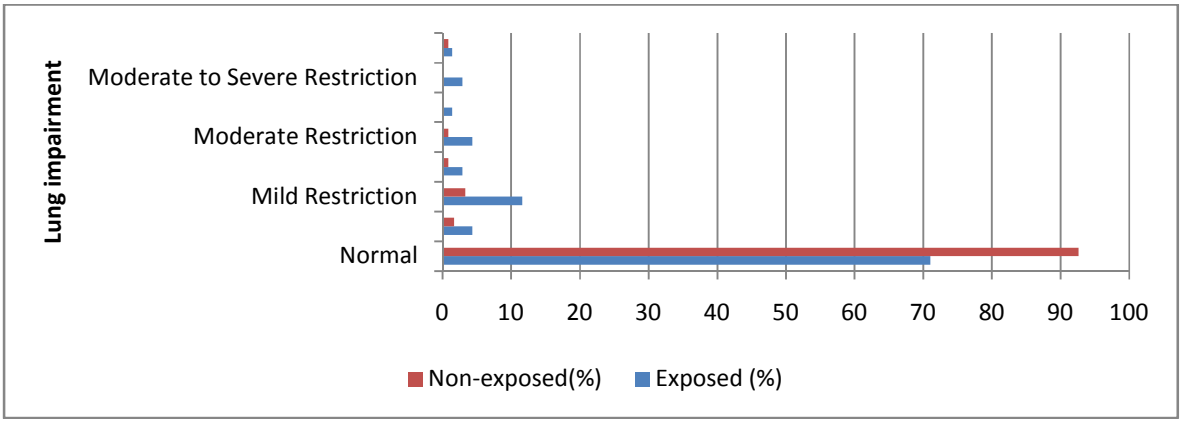
Factor	Total n (%)	Male n (%)	Female n (%)	P value
Age (years)				
<25	83(43.7)	50(41.7)	33(47.1)	0.560
25+	107(56.3)	70(58.3)	37(52.9)	

Working experience (PA years)				
<1	39(56.5)	26(53.1)	13(65.0)	0.522
1+	30(43.5)	23(46.9)	7(35.0)	
Body Mass Index				
<18.5	28(14.7)	22(18.3)	6(8.6)	0.179
18.5 – 24.9	116(61.1)	71(59.2)	45(64.3)	
25+	46(24.2)	27(22.5)	19(27.1)	

PA – Petrol attendants

Figure 1 shows lung function impairment by exposure. The prevalence of lung function among the exposed participants was 29.0% and 7.4% among the non-exposed (p<0.001).

Figure 1: Lung function impairment by exposure



Overall, 120 (63.2%) were males and 43.7% were of age <25 years. Regarding lifestyles, 7.4% of participants smoked and 42.1% drunk alcohol. The only factor that was significantly (p=0.004) associated with exposure was body mass index (Table 2).

Table 2: Distribution of various variables between exposed and non-exposed participants

Variable	Total n (%)	Exposed n (%)	Non-exposed n(%)	P value
Sex				
Male	120(63.2)	49(71.0)	71(58.7)	0.124
Female	70(36.8)	20(29.0)	50(41.3)	
Age (years)				
<25	83(43.7)	31(44.9)	52(43.0)	0.913
25+	107(56.3)	38(55.1)	69(57.0)	
Smoking				
Yes	14(7.4)	6(8.7)	8(6.6)	0.810
No	176(92.6)	63(91.3)	113(93.4)	
Alcohol				
Yes	80(42.1)	29(42.0)	51(42.1)	0.891
No	110(57.9)	40(58.0)	70(57.9)	
Body mass index				
<18.5	28(14.7)	18(26.1)	10(8.3)	0.004**
18.5- 24.9	116(61.1)	36(52.2)	80(66.1)	
25+	46(24.2)	15(21.7)	31(25.6)	
Chronic Bronchitis				

Yes	6(3.2)	3(4.3)	3(2.5)	0.782
No	184(96.8)	66(95.7)	118(97.5)	
Pulmonary Tuberculosis				
Yes	2(1.1)	1(1.4)	1(0.8)	0.738
No	188(98.9)	68(98.6)	120(99.2)	
Cough				
Yes	23(12.1)	11(15.9)	12(9.9)	0.321
No	167(87.9)	58(84.1)	109(90.1)	

Significant reductions in lung function parameters (FEV1, FVC and PEF) were observed among the exposed group compared with the non-exposed group (p values 0.004, 0.010 and 0.031, respectively) as shown in Table 3.

Table 3: Lung function test among exposed and non-exposed participants

Factor	Exposed mean(SD)	None exposed mean(SD)	P value
FEV1 %	98.8 (23.2)	109.0 (23.8)	0.004*
FEV1PRED1	3.26(0.75)	3.53 (0.76)	0.021*
FEV1PRED	3.32(0.47)	3.29(0.52)	0.746
FVC	95.6 (23.6)	104.9(24.1)	0.010*
FVCPRED1	3.65(0.92)	4.02(0.88)	0.007*
FVCPRED	3.96(0.82)	3.93(0.87)	0.789
FEV1/FVC	110.2(12.42)	167.1(13.71)	0.123
FEV1/FVCPRED1	82.67(1.43)	82.83(1.53)	0.503
FEV1/FVCPRED	90.5(11.3)	88.7(11.5)	0.306
PEF	61.5(22.4)	69.1(23.3)	0.031*
PEFPRED1	5.3(1.9)	5.9(1.9)	0.056
PEFPRED	8.6(1.24)	8.60(1.33)	0.849

FEV 1: forced expiratory volume in the first second, FEV1PRED : FEV1 Prediction, FVC: forced vital capacity, FVCPRED: FVC Prediction PEF: peak expiratory flow , PEFPRED : PEF Prediction. <0.05 in the p value is considered of significance.

After adjusting for body mass index, exposed participants were 2.18 (95% CI, 1.39, 3.42) times more likely to have lung function impairment compared to the non-exposed participants. Compared to participants with body mass index of 25 or more, participants who had body mass index of <18.5 were 2.87 (95% CI [1.18, 6.99]) times more likely to have lung function impairment. These results are shown in Table 4.

Table 4: Association between group and lung function impairment adjusted for body mass index

Factor	Adjusted Odds ratio	95%Confidence Interval
Group		
Exposed	2.18	(1.39, 3.42)
Non-exposed	1	
Body Mass Index		
<18.5	2.87	(1.18, 6.99)
18.5- 24.9	1.86	(0.83, 4.17)
25+	1	

Discussion

This is the first paper ever done on the association between exposure to fuel and respiratory health among fuel attendants in Ndola, Zambia. A higher prevalence of lung function impairment was observed among fuel attendants (29.0%) than non-exposed participants (7.4%) with significant reduction in FEV1, FVC and

the PEF values among the exposed participants. A prevalence of lung function impairment observed in the current study of 29% among fuel attendants is much lower than the 42% observed in Gujarat, India [12]. The lower prevalence of lung function impairment in the current study may be as a result of short exposure duration to which 56.5% of the petrol attendants had been exposed for <1 year. Meanwhile, participants in India had been observed for at least 1 year. Long exposure to fuel has been associated with lung function impairment [5, 8, and 11].The finding in the current study of significant reductions in FEV1, FVC and PEF among exposed participants compared to non-exposed participants have been reported elsewhere. The FEV1 and FVC were shown to be reduced in petrol attendants compared to the controls [5, 8-11]. Furthermore, the PEF in this current study was observed to be reduced among the exposed group and similar findings were presented by Madhuri *et al* [11]. Benzene in petrol may be absorbed in the human body through the respiratory tract [13] and may cause impaired lung function. No significant association was observed between duration of work and lung function impairment in the current study partly because of the short duration of exposure to fuel. Exposed participants had only been working for less than 5 years. Other studies have observed a tendency of the petrol pump attendants to have lung impairment after being exposed for more than 3 or 5 years [5, 8,11]. The cumulative effect of benzene in petrol [13] and Sulphur Dioxide (SO2) [14] in diesel may cause lung function impairment. In the current study we found a significant association between body mass index and lung function. Lean participants were more likely to have impaired lung function compared to overweight participants, contrary to the finding by Uzma *et al* [15] who observed a significant positive linear relationship between body mass index and years of exposure. Differences in diet between participants in the current study and those studied by Uzma et al may partly explain the observed different associations in the two populations.Exposed participants were about two times more likely to have lung function impairment compared to the unexposed group. The benzene in petrol and SO2 in diesel may cause respiratory ill health in fuel attendants. The lower prevalence of lung impairment among the student controls could be attributed to hospital acquired respiratory infections where they learn. Some of the limitations encountered during this study were during the collection of data. With regards to the exposed, there was a low response rate about 69%. This in itself may have introduced biasness to the study as many who did not take part may have had lung function impairments.

Conclusion

Study concluded that there is an association between exposure to fuel and lung function impairment among fuel attendants. Thus it is pertinent that they are provided with masks to protect them from constantly inhaling the fuel fumes and also medical check-ups be provided before employment and during their period of work.

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