

Impact of Fuel Exposure on Ventilatory Function among Petrol Pump Attendants in Thies, Senegal

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Abstract

Introduction: Petrol pump attendants are exposed to toxic substances in fuels. The release of petrol fumes during fuel refuelling is a repeated and often harmful source of exposure for petrol pump attendants. The purpose of our study was to evaluate the ventilatory disorders related to fuel exposure among petrol pump attendants.

Materials and Method: Forty petrol pump attendants have been recruited. The study included a medical survey with a questionnaire that examined anthropometric characteristics, seniority, smoking habits and working conditions. The study included a medical survey with a questionnaire that examined anthropometric characteristics, seniority, smoking habits and working conditions. All our subjects received a basic and post-bronchodilator spirometry. The targeted respiratory functional disorders were bronchial obstruction, restrictive syndrome and mixed syndrome. Obstructive syndrome has been reported on the basis of: FEV1/FVC and/or FEF25-75% less than 80%. Functional restriction was defined on the basis of a decrease in FVC <80% and the normal FEV1/FVC ratio. The mixed syndrome was retained firstly before the combination of the two obstructive and restrictive spirometric anomalies.

Results: We noted 20% of active smokers and 25% of ex-smokers. The average length of service was 9.4 ± 7.05 years. All of the petrol pump attendants used incomplete means of protection. No employee was receiving medical follow-up. Most subjects (52.5%) were unaware of the risks associated with fuel exposure. Respiratory functional disorders were dominated by isolated obstructive ventilatory disorder (OVD) in 45% of subjects and were mainly located in the distal bronchi (65%). Besides, 12.5% of subjects had an isolated restrictive functional disorder (RFD) and a mixed syndrome in 27.5% of cases. Obstructive and mixed ventilatory disorders were more important according to smoking status. The different ventilatory disorders (VD) appeared from the beginning of exposure with a predominance of obstructive ventilatory disorders. Mixed ventilatory disorders increased significantly after 10 years of exposure.

Conclusion: Exposure to petrol / diesel fumes has harmful effects on the ventilatory function of petrol pump attendants.

Key words: petrol pump attendant, fuel, ventilatory disorders, spirometry, Senegal.

Introduction

Personnel working in petrol stations are exposed not only to air pollutants, but also to organic and inorganic components in fuels (diesel oil and petrol). During the distribution chain of these fuels, hydrocarbon fumes are released, leading to overexposure of employees working

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in petrol stations, particularly petrol pump attendants. The fuels contain a variety of chemicals including small amounts of benzene and sometimes lead that are absorbed by the human body through the respiratory tract or through skin contact. These can cause respiratory symptoms and impaired ventilatory functions¹. Animals exposed to diesel exhaust gas have been shown to develop impaired lung function^{2,3}. In Senegal, a developing country, the fuel trade is growing considerably with the advent of new local fuel distribution companies. Every day, about fifty employees working in the 26 petrol stations in the city of Thiès are directly exposed to the fuels and the additives they contain. The purpose of this study was to determine the ventilatory disorders related to fuel exposure among petrol pump attendants working in the city of Thiès (Senegal).

Material and Method

Participants

The study protocol was approved by the ethics committee of the University of Thiès. We conducted a descriptive and analytical cross-sectional study over a three-month period (29 June to 02 October, 2018). Our study population consisted of fuel-exposed petrol pump attendants, all male. All these workers had at least one year of seniority. The study included a medical survey (questionnaire, clinical examination and spirometry). The questionnaire covered physical characteristics (gender, height, weight, age), seniority in the activity, working conditions, smoking habits. For cigarette smoking intoxication, we have identified active smokers, ex-smokers and non-smokers. Subjects are categorized as smokers: those who smoked during the 30 days preceding the survey, former smokers: those who smoked for more than 30 days but did not smoke during the 30 days preceding the survey; non-smokers are those who had never smoked or who had smoked for less than 30 days. The exclusion criteria were the presence of a thoracic deformity or a progressive cardiopulmonary pathology known at the time of the study.

Spirometric parameters: Basic and post-bronchodilator spirometry were performed in all our subjects. Spirometry was performed using a regularly calibrated Jaeger PNEUMO Care Fusion device coupled with a computer in which data analysis software is installed. Explanations and supporting illustrations were provided in advance regarding the conduct of the examination for better cooperation of the subjects. After

the various tests were performed, lung volumes and bronchial flows were examined and the rates of variation of the different parameters were taken into account with respect to the reference standards (ERS/ATS 2005)⁴. The best test was selected taking into account the subject's degree of cooperation and the aspect of the flow-volume curve. Volumes, lung capacities and bronchial flows were examined (basic and post-bronchodilator spirometric parameters). The rates of variation of the various parameters in relation to the reference standards have been taken into account.

The parameters measured were the Maximum Expiratory Volume at the first second (FEV1), the Forced Vital Capacity (FVC), the Tiffeneau ratio (FEV1/FVC) and the maximum expiratory flows (FEF) including FEF75%, FEF50%, FEF25% and FEF25-75%. Obstructive syndrome was defined on the basis of a lower FEV1/FVC ratio (less than 80%) and FEV1 < 80% of the predicted value. The diagnosis of obstructive ventilatory disorders was made according to the level of impairment in the airways:

- total obstruction: FEV1/FVC < 80% of the predicted value and $FEF_{25-75\%} < 80\%$ of the predicted value,
- proximal obstruction only: FEV1/FVC < 80% predicted value and $FEF_{25-75\%}$ normal,
- distal obstruction only: $FEF_{25-75\%} < 80\%$ of the predicted value and FEV1/FVC normal.

The functional restriction was retained ahead of a decrease in CVF < 80% of the predicted value and a normal CVF1/CVF ratio (>80%).

Statistical Analysis

Data collection was based on pre-established survey forms and spirometric data forms using Excel 2013 software. The statistical analysis was done using Excel and Prism software. Qualitative variables were expressed in proportions and quantitative variables in terms of averages and standard deviations. The Student test was used to search for a link between the parameters. The limit of significance was set at $p < 0.05$.

Results

A total of forty (40) petrol pump attendants were recruited. The average age was 37.77 ± 3.99 years with a more represented age group of 40 to 50 years (35%).

The average BMI was 21.77 ± 3.05 kg/m² (Table I). The seniority in the job was estimated at 9.4 ± 7.05 years. In addition, our subjects worked an average of 76 ± 12 hours per week with extremes ranging from 60 to 96 hours. Our study population was mainly composed of non-smokers (55%) with a lower proportion of active smokers (20%) having an average smoking consumption of 5.6 packs per year with extremes ranging from 2 to 13.5 packs per year.

All of our subjects wore safety shoes and uniforms based on the colour of their petrol station. However, none of them used gloves and only one gas station attendant reported that he wore a face mask during his shift. Four (4) employees had received a pre-employment medical examination, representing 10% of our study population. On the other hand, no employee received regular medical follow-up. Nevertheless, 52.5% of the petrol pump attendants recruited were unaware of the occupational risks related to fuel exposure when questioned.

The prevalence of respiratory function abnormalities was 85% in the study. Obstructive, restrictive or mixed ventilatory disorders were noted in our subjects. The most common ventilatory disorders (VD) were isolated obstructive types (45%) which were mainly located in the distal bronchi (65%). Besides, 27.5% of the subjects had mixed ventilatory disorders and a restrictive syndrome in 12.5% of the cases (Figure 1).

Depending on seniority in activity (duration of exposure), we noted at the beginning of exposure (group 1 to 10 years) a significantly higher prevalence of obstructive ventilatory disorders compared to restrictive syndrome ($p=0.0001$) and mixed syndrome ($p=0.02$). In addition, mixed ventilatory disorders increased significantly after 10 years of exposure (26.9% of workers with 1 to 10 years of exposure compared to 28.6% of the group with more than 10 years of seniority ($p=0.0001$) (Figure 2).

Obstructive syndrome was significantly higher among ex-smokers than among smokers ($p=0.005$). Furthermore, this syndrome is also significantly higher among active smokers compared to non-smokers ($p=0.0001$). Mixed ventilatory disorders were significantly higher among smokers compared to non-smokers ($p=0.0001$) (Figure 3).

The analysis of post-bronchodilation spirometry data made it possible to objectify 10% of work-related asthma cases in our study population (Figure 4). We

noticed a negative correlation between the base FEV1 and seniority ($p=0.0193$ and $r=-0.36$) (Figure 5).

Discussion

This study has identified the main work-related risks of the petrol pump attendant job in the informal economy in our country. Paradoxically, the decisive role of the petrol pump attendant in the operation of the petrol station exposes him to the health risks arising from the handling, especially of fuel distribution pistons, with the failure to comply with the safety measures often observed among these exposed groups. Workers at these petrol stations are in continuous contact with fuels and constantly inhale the particles emitted by the vehicles they refuel⁵. Moreover, the need for petrol pump attendants sometimes to sniff the tank cap to check the fuel type in order to avoid errors, results in overexposure to fuel fumes⁶. In our cross-sectional study, the results confirm a ventilatory function impairment of petrol pump attendants exposed to petrol / diesel fumes. Similar results have been observed in previous studies^{7,8}. In our study, abnormalities in ventilation function are significant in 85% of the exposed subjects, which could be explained by the lack of use of personal protective measures (PPM) during work, poor air quality in petrol pumps, multiple tasks (refuelling, storage and workplace cleaning), and lack of knowledge about the harmful effects of fuels. Obstructive syndrome predominated in our exposed subjects. Pellegrino et al⁹ had found similar results with changes in FEV1 and FEV1 / FVC ratio more common than changes in FVC. The reduction in the FEV1 / FVC ratio may indicate a slight obstruction of the respiratory tract. Our results are consistent with what is found in the observations of Kesavachandran et al.¹⁰ and Ayres et al.¹¹ which showed that workers exposed to diesel and automatic exhaust systems had increased respiratory tract resistance. Studies involving particle distribution in the human lung have shown a major impact site in the terminal bronchioles¹² where most chronic obstructive pulmonary disease begins¹³. It is clearly established that the loss of bronchiolar attachment due to the destruction of the extracellular matrix secondary to the deposition of toxic particles is the cause of the reduction in FEF25-75%^{14,15}.

The restrictive syndrome and the mixed deficit observed in our study seem predictable with regard to the substances handled and the working conditions. Indeed, repeated chemical aggression initially leads to obstruction, secondary alveolitis will lead to pulmonary

fibrosis whose ventilatory expression is the restrictive syndrome¹⁶. Our study found an increase in respiratory failure among smokers. Many previous studies have shown the potentiating effect of tobacco on respiratory risk at work-related exposures^{17,18}. Weisel et al.¹⁹ found that work-related inhalation exposure to benzene could be increased among employees who smoke.

The prevalence of asthma in our subjects is 10%. Studies in healthy and asthmatic adult populations have shown a clear association between exposure to benzene and total volatile organic compounds (VOCs) on the one hand and, the occurrence of asthmatic respiratory manifestations (diagnosed asthma, clinical or functional symptoms suggestive of asthma)^{20,21} on the other hand.

The increasing tendency of lung parenchyma involvement through an increase in mixed syndrome relative to seniority in exposure suggests a probable influence of exposure duration on respiratory function. Our results corroborate those of Solanki et al.²² who observed that, as the duration of exposure increases, a progressive decrease in FEF25-75 and FEV1 / FVC, pointing to obstructive pathology and leading to a mixed type of respiratory deficit. In our work, negative correlations were found between job tenure and FEV1. These results could suggest an increase in bronchoconstriction in relation to an irritant effect related to VOC exposure²³.

Table I: Anthropometric data

Anthropometric data	Average	Min	Max
Age (years)	37.77 ± 3.99	21	59
Weight (kg)	71.15 ± 10.54	54	96
Height (cm)	180.65 ± 5.74	168	190
BMI (kg/m ²)	21.77 ± 3.05	17	27

BMI : Body Mass Index

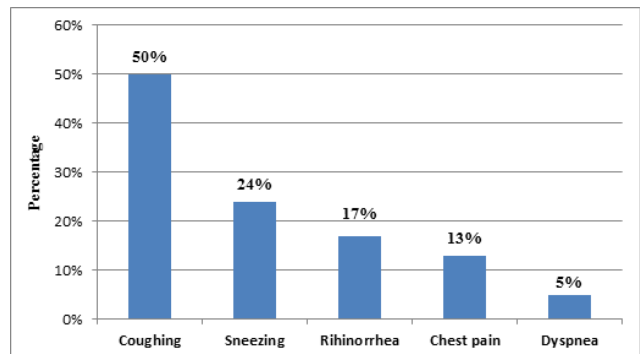


Figure 1 : Distribution of the population according to the different ventilatory disorders.

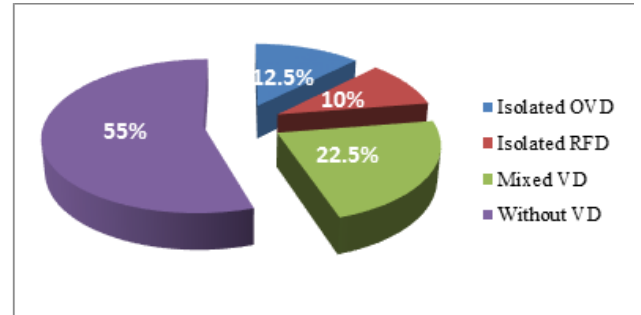


Figure 2: Distribution of ventilatory disorders by seniority (years).

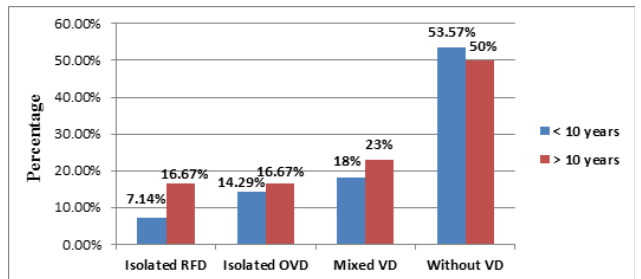


Figure 3: Distribution of ventilatory disorders by smoking status

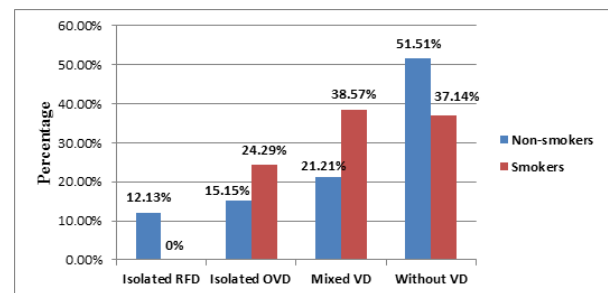


Figure 4: Prevalence of asthma in our population.

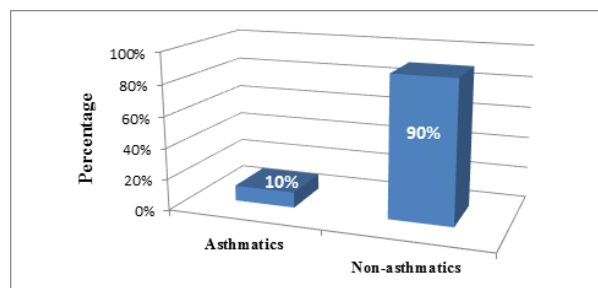


Figure 5: Correlation between FEV1 and seniority.

Conclusion

The prevalence of ventilatory disorders is high in the petrol pump worker environment. Small airways are probably the most critical site of lung damage. Smoking and seniority in the job increase the risks associated with fuel exposure. Frequent health check-ups and regular follow-up of ventilation function would be beneficial. The proper use of safety measures such as protective masks, gloves could be adopted to reduce the health risks associated with chronic exposure to fuels. Enhanced individual and collective protection measures must be implemented to reduce the health risks associated with fuel exposure.

Ethical Clearance: Ethics committee of the University of Thies

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Conflict of Interest: Nil

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