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RESEARCH ARTICLE

Pulmonary function tests in compressed natural gas pump workers in Surat city

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ABSTRACT

Background: Various studies have known abatements in lung function and several other health problems associated with longstanding air pollution exposure. One of the most cost-effective and environmental alternative of conventional fuels (petrol and diesel) is compressed natural gas (CNG). The increasing use of CNG as a fuel (as it is safe and cheap as compare to the conventional fuels) can add one more bug to the list of work-related disease. **Aims and Objectives:** This study is to evaluate the respiratory functions of CNG pump workers. **Materials and Methods:** The present study was held on 82 male subjects. The study group included of non-smoking healthy adult males, age group of 20–40 years working in different CNG stations in Surat city for >6 months and 8 h per day. The control group included of non-smoking healthy adult males, age group of 20–30 years working or studying in the Surat Municipal Institute of Medical Education and Research (SMIMER). **Results:** Out of 82 male subjects, 30 subjects were control and 52 subjects were CNG station workers. The study group comprised of 52 healthy non-smokers in the age group of 20–40 years working in different CNG station in Surat city for >6 months and 8 h/day. The control group comprised of 30 healthy non-smokers males between the age group of 20–30 years working or studying in the SMIMER. **Conclusion:** In this study, we have not found statistically significant deterioration in pulmonary functions of CNG pump workers when compared to controls.

KEY WORDS: Pulmonary Function Test; Lung Function Test; Compressed Natural Gas Workers

INTRODUCTION

India is a speedily emerging country and automobiles plying on roads are increasing day by day. This has led to a rise in fuel stations and pump workers and also exposure of labors to vapors of fuel and gases from exhaust of vehicles, which have a deleterious effect on the respiratory system. Health complications posed by the chemicals at the work environment of an individual are closely linked to nature and the level of exposure to hazardous chemicals in these pollutants.[1] With increasing number of vehicles in the most of the townships and cities of India and consistent increasing air pollution, occupational diseases are increasing as well.[2] Many epidemiological studies have documented decrements in lung function and many other health problems associated with long-term air pollution exposure.[3-6] Petroleum purifying products are constituted by cycloalkenes, the conventional and the branched chained alkenes which are continuous sources of pollution in various occupational surroundings.

One of the most economical and eco-friendly alternative of conventional fuels, that is, petrol and diesel are compressed natural gas (CNG). As it is safe and cheap as compare to the conventional fuels, the use of CNG as a fuel is increasing nowadays, which can add one more disease to the list of occupational disease. There are numerous studies which

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are conducted in the past to know the respiratory hazards of pollutants that are produced after combustion of petrol or diesel and there are a few studies which had tested the effects of these fuels before they are combusted, that is, effects on respiratory system of the people over who work as petrol feeling attendant at fuel pumps. However, there is almost no study that has ever been executed to evaluate the effects of CNG fumes to which the CNG filling workers (pump attendants) are exposed for various durations at their working places. Hence, this study is aimed to identify the deterioration (if any) in the respiratory function of CNG filling workers of various CNG pump stations and to assess the same according to the duration of exposure, to check the effects in various age groups, and to observe the effects of CNG in smokers and non-smokers of the city.

Lung function tests have been of increasing interest for qualitative and quantitative assessment of functions of healthy lung in patients. Hence, this study is executed to know the effects of CNG on respiratory functions in exposed people before its combustion, that is, CNG filling workers.

The instrument used for the evaluation of respiratory function tests is computerized spirometer (RMS Medspiror).

Pulmonary function testing is done by spirometers which are non-invasive investigative devices for screening of lung function. Spirometry tests can be performed fast at equally low cost. The most common prevalence of airway diseases such as asthma and bronchitis and pulmonary function tools have become crucial investigative tools, in clinical as well as in industrial and preventive medicine. Spirometry sensor through a mouthpiece to the test subject's mouth which is measures flow rates and resulting volumes. The most common and standardized test comprises an assessment of forced expiration after a complete inhalation, allowing the determination of forced vital capacity (FVC) and the forced expired volume during the 1st s (FEV1). Recording of the test trace is taken as a forced Spirogram (volume over time) or as a flow-volume loop (flow against volume). Although FVC and FEV1 are the most common, loads of parameters can be derived when evaluating forced expiration.

The aim of this study is to assess the respiratory functions of CNG pump workers to evaluate the spirometry parameters of CNG station workers, to evaluate the same according to the duration of exposure, to check the effects in various age groups, and to observe the effects of CNG in smokers and non-smokers.

MATERIALS AND METHODS

The present study was conducted on 82 male subjects. The study group comprised of non-smoking healthy males in the age group of 20–40 years working in different CNG pump station in Surat city for >6 months and 8 h per day. The control group comprised of non-smoking healthy adult males between the age group of 20 and 30 years working or studying in the Surat Municipal Institute of Medical Education and Research (SMIMER). To analyze the effects based on duration of exposure in years, CNG pump workers were divided into two groups: Group 1 (Exposed for ≤5 years) and Group 2 (Exposed for >5 years). The subjects were selected after taking a thorough history and clinical examination.

Inclusion Criteria

The following criteria were included in the study:
1. Working at CNG pump for >6 months
2. Age >18 years.

Exclusion Criteria

The following criteria were excluded from the study:
1. Known cases of allergic and other respiratory disease
2. Known cases of diabetes mellitus, hypertension, and other cardiac disease
3. Cases of visible spinal cord deformity
4. Case of ongoing common diseases such as common cold and cough
5. Smokers and drug addicts
6. Recent history of abdominal/thoracic surgery or trauma

With permission of the managers of the respective CNG stations, the subjects were allowed to participate in the study. The spirometer was taken to their respective pump stations and all the tests were conducted on sites without hampering their duty at the pumps.

Ethical clearance was taken from the Institutional Ethical Committee and each subject gave the verbal consent after understanding the usefulness and the ease of procedure they were to undergo.

The physical parameters noted by physical examination for age in years, height in centimeters, and weight in kilograms. Weight of each participant was noted on a standard weighing machine under standard conditions. For measuring height, each subject was made to stand restfully with shoulders, back, buttocks, heels, and head touching a wall and the feet parallel. Arms hang naturally by the sides. The external auditory meatus and lower border of the orbits were in the plane parallel to the floor. Standing height was measured with a good steel measuring tape by marking the highest point of the vertex on the wall.

Pulmonary Function Tests used in Study

Pulmonary functions were tested using RMS Medspiror® (a self-calibrating computerized spirometer that fulfills the criteria for standardized lung function tests).

The parameters studied were as follows,

1. FVC
2. FEV1
3. Forced expiratory volume in 3 s
4. FEV1/FVC (FEV1%)
5. Peak expiratory flow rate (PEFR).

Tests were performed using the suitable standards outlined by the American Thoracic Society with subjects in a standing position and wearing nose clips.[7] Following deep inspiration into the mouthpiece attached to the pneumotachometer, the subjects were asked to breathe forcefully. Expiration was maintained for a minimum period of 3–4 s. 3–4 trails of inspiratory and expiratory efforts were made and the uppermost reading was taken for statistical analysis.

Statistical Methods

Statistical methods used in the present study were mean (M) and standard deviation (SD), independent sample *t*-test using SPSS-16. $P < 0.05$ was considered statistically significant.

RESULTS

The study was conducted on total 82 volunteers. Out of which 52 were subjects who work on CNG pump station as filling attendants at various CNG pump stations of Surat city and 30 were healthy controls who work/study in SMIMER [Figure 1]. The mean value of the ages of the subjects was 26.3846 ± 6.24077 and the mean value of the ages of the controls was 20.3333 ± 0.99424. Figure 2 indicates the means of ages of subjects and controls with SDs. The mean value of the heights of the subjects was 164.44 ± 7.47 and the mean value of the heights of the controls was 173.40 ± 6.17. Figure 3 indicates the means of heights of subjects and controls with SDs.

The mean value of the weights of the subjects was 59.6731 ± 8.09435 and the mean value of the weights of the controls was 65.7333 ± 13.81637. Figure 4 indicates the means of weights of subjects and controls with SDs ($P < 0.014$). The mean value of the FVCs of the subjects was 3.2992 ± 0.71185 and the mean value of the ages of the controls was 3.5293 ± 0.66448. Figure 5 indicates the means of FVCs of subjects and controls with SDs ($P < 0.153$). The mean value of the FEV1s of the subjects was 3.1031 ± 0.49522 and the mean value of the FEV1s of the controls was 3.3117 ± 0.43381. Figure 6 indicates the means of FEV1s of subjects and controls with SDs ($P = 0.058$). The mean value of the PEFRs of the subjects was 7.3787 ± 1.23457 and the mean value of the PEFRs of the controls was 7.0243 ± 1.25444. Figure 7 indicates the means of PEFRs of subjects and controls with SDs ($P = 0.217$). The mean value of the ratios of FEV1/FVC of the subjects was 95.2094 ± 7.86290 and the mean value of the ratios of FEV1/FVC of the controls was 95.4840 ± 8.28668. The following table and graph [Figure 8] indicate the means of ratios of FEV1/FVC of subjects and controls

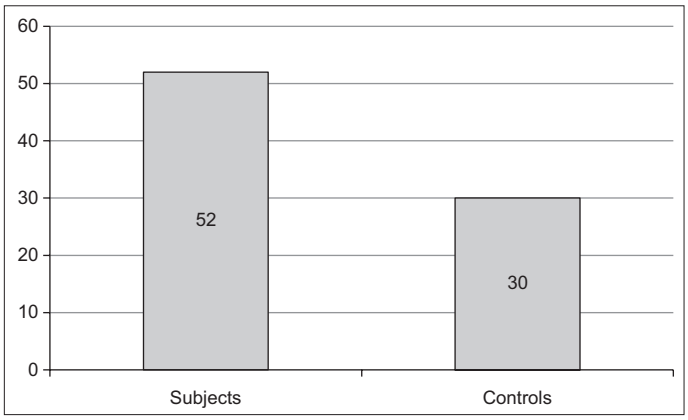

Figure 1: The bar diagram showing number of subjects and controls

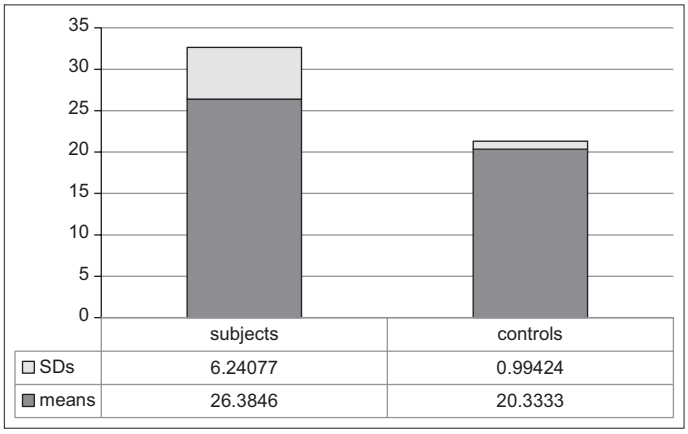

Figure 2: The bar diagram showing the mean value of the ages

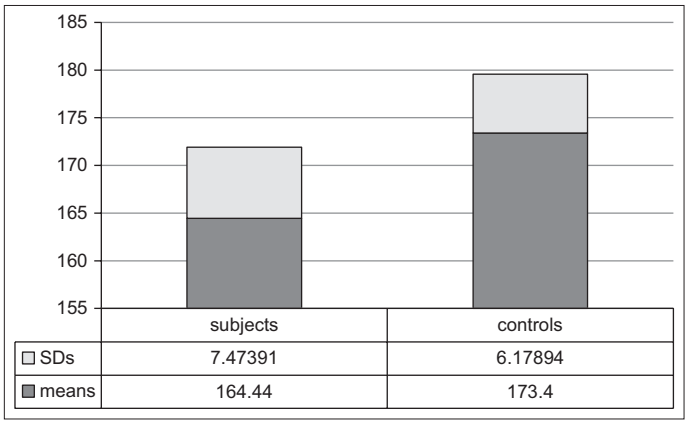

Figure 3: The bar diagram showing the mean value of the heights

with SDs ($P = 0.882$). To evaluate the effects of duration of exposure on various components of pulmonary function tests, 52 subjects were divided in to two groups as follows and means of FVCs, FEV1s, PEFRs, and ratios of FVC: FEV1 were compared statistically by applying independent *t*-test [Tables 1 and 2].

DISCUSSION

The various respiratory function parameters were noted and linked between the subjects and the controls. In addition, the

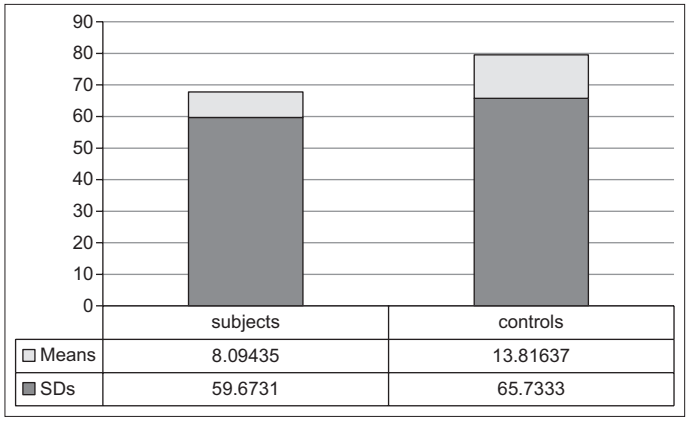

Figure 4: The bar diagram showing the mean value of the weights

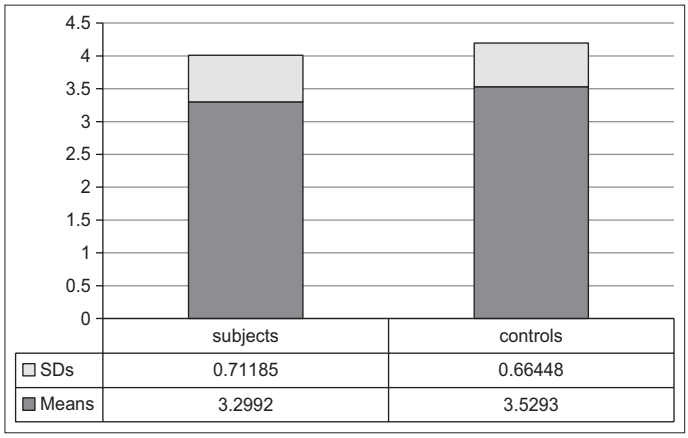

Figure 5: The bar diagram showing the mean value of the FVCs

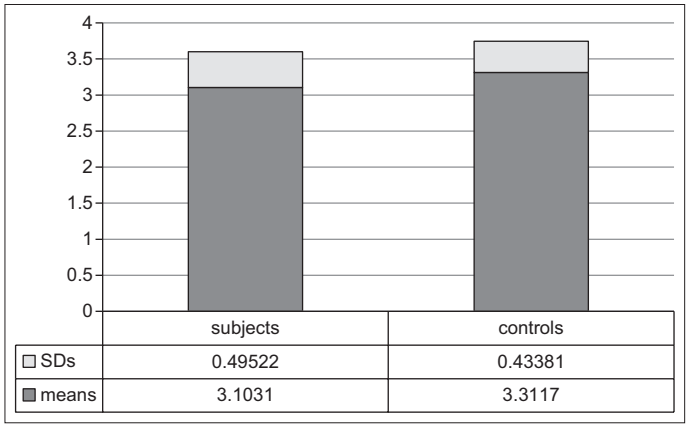

Figure 6: The bar diagram showing the mean value of the FEV1s

intergroup comparison of the various respiratory parameters was done between the subjects on the basis of the period of the service at the CNG pumps, that is, duration of exposure. In our study, we did not encounter any worker who smoked nor was any worker allowed to work for shift of >8 h. We also did not come across any female workers. Thus, investigators can study the effect of smoking or the effect of longer daily exposure on CNG pump workers. It would also be interesting to see if there is significant pulmonary function alteration in females when compared to males.

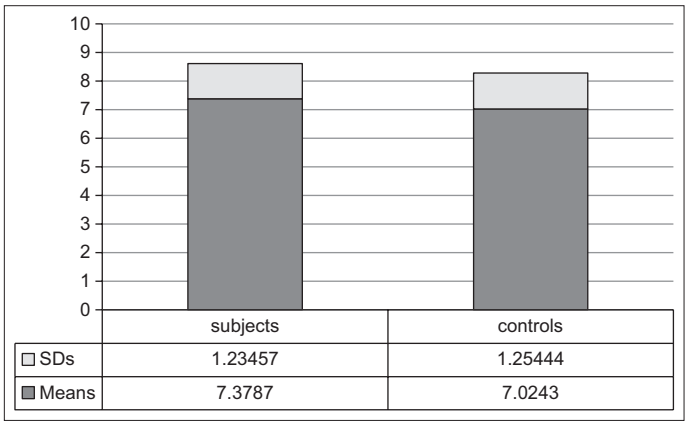

Figure 7: The bar diagram showing the mean value of the PEFRs

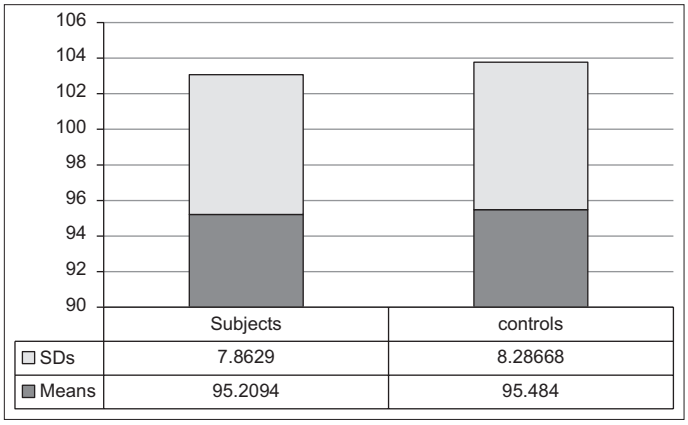

Figure 8: The bar diagram showing the mean value of the ratios of FEV1/FVC

Effects of CNG on Mean of Following Respiratory Parameters of CNG Station Attendants (Subjects) and Control Group

1. FVC
2. FEV1 (percentage of FVC in 1 s)
3. PEFR
4. Ratio FEV1: FVC.

Effects of CNG on Various Parameters of Respiratory Functions of the CNG Pump Attendants (subjects) Based on Years of Exposure to CNG

All the subjects had common per day duration of exposure at their respective working places, that is, 8 h per day. Hence, the error of disproportional per day exposure of subjects was eliminated. There were divided into two groups, as shown in Table 2.

As shown in Table 2, the mean FVCs, FEV1s, PEFRs, and ratios of FEV1:FVC remained statistically insignificant on comparison for both Group 1 subjects and Group 2 subjects. This indicates that spirometric parameters of lung functions are not altered or they remain constant without any deterioration whether the duration of exposure is >5 years or more than 5 years. Not a single routine parameter showed any significant

Table 1: Summary of parameters and comparison of means between study and control groups

Parameter	Subjects	Controls	*P*-value	Significance
FVC (Mean±SD)	3.2992±0.71185	3.5293±0.66448	0.153	NS
FEV1 (Mean±SD)	3.1031±0.49522	3.117±0.43381	0.058	NS
PEFR (Mean±SD)	7.3787±1.23457	7.0243±1.25444	0.217	NS
FEV1:FVC (Mean±SD)	95.2094±7.8629	95.484±8.28668	0.882	NS

FVC: Forced vital capacity, FEV1: Forced expired volume during the 1st s, PEFR: Peak expiratory flow rate, NS: Not significant

Table 2: The summary of parameters and comparison of means between Group 1 and Group 2

Parameter	Group 1	Group 2	*P*-value	Significance
FVC (Mean±SD)	3.2472±0.5952	3.4162±0.9354	0.473	NS
FEV1 (Mean±SD)	3.1328±0.4923	3.0362±0.5112	0.525	NS
PEFR (Mean±SD)	7.54861±1.2179	6.9962±1.2228	0.140	NS
FEV1:FVC (Mean±SD)	96.9461±4.0185	91.3019±12.206	0.052	NS

FVC: Forced vital capacity, FEV1: Forced expired volume during the 1st s, PEFR: Peak expiratory flow rate, NS: Not significant, Group 1: Exposed for≤5 years, Group 2: Exposed for>5 years

variation which is perfectly contrary to the studies which were conducted on petrol pump workers on the basis of exposure.

Our study is in concurrence with a similar international study done at Karachi, Pakistan, in 2013. Like our study, they also did not find any alteration in pulmonary functions of CNG pump workers. However, with petrol pump workers, significant deterioration in pulmonary functions was seen, especially with longer duration of exposure. Sushil Dube, Mungal S U, and Mukund Kulkarni from the Dept. of Physiology, Government Medical College, Nanded, Maharashtra, India, mentioned in their study that the health issues posed by the pollutants at the work atmosphere of an individual are closely connected to the nature and level of exposure to harmful chemicals.[8] Beside this, rapidly increasing number of vehicles in most cities and corresponding increase in air pollution are a cause of grave concern.[8] Dr. Aparajita from Meerut, Uttar Pradesh, said in their study that air pollution from automobiles is an unavoidable part of the urban life throughout the world. A long exposure to the air pollutants leads to harmful effects on the pulmonary functions. Sandip M Hulke, Prashant M Patil, Avinash E Thakare, and Yuganti P Vaidya had similarly studied pulmonary function test. Sadiqua Begum and MB Rathna from Mysore also performed the study on pulmonary function tests.

Our study has not found any significant alteration in lung function of CNG pump workers but similar investigations in petrol pump workers have documented statistically significant deterioration. Hence, it can be safely assumed that CNG fumes are less toxic than other fuel fumes. However, it would be interesting to compare pulmonary functions of petrol and CNG pump workers in a single study. Even though the pulmonary functions are not altered in respect to the prolonged duration of exposure to the CNG, periodic examinations of CNG pump workers can be implemented to evaluate the pulmonary functions. The present study could not find any significant changes in the pulmonary functions but it is still advised to take up all preliminary precautions at filling stations. Finally, it would also be interesting to note the effect of these fumes on functions of other organs besides lungs such as liver, kidney, or blood.

CONCLUSION

In this study, we have not found statistically significant deterioration in pulmonary functions of CNG pump workers when compared to controls. Moreover, we have not found statistically significant deterioration in lung function with increasing years of exposure in CNG pump workers. Thus, we conclude that CNG and fumes resulting from its leakage at filling stations do not have statistically significant effect on pulmonary function on CNG pump workers.

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