



EVALUATION OF THE LUNG FUNCTION AND RELATED PARAMETERS AMONG CLOTHES/CLOTHING DEALERS IN CALABAR METROPOLIS, NIGERIA

ARIBO, E.O., BEKEH, E.B. AND UTIONKPAN, L. P
Email: ekpearibo@gmail.com

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ABSTRACT

The clothes/clothing industry is a fast-growing business with increasing number of people engaged in the sales or distribution of its products. Most studies on pulmonary health following exposure to textiles have concentrated on workers in the factories/industries. Workers in these industries have been reported severally to have pulmonary function impairment and other pulmonary diseases. There is however paucity of information on the pulmonary function of traders involved in the sale of the textile products (clothings), hence this study. Lung function indices were evaluated in the standing position by spirometry on 132 male fabric dealers and same number of age-matched male controls. The results showed no significant differences in the ages and anthropometric parameters (height, weight, chest circumference, body mass index) between fabric dealers and control groups. Forced expiratory volume in the first second (FEV₁), forced expiratory volume in one second expressed as a percentage of forced vital capacity (FEV₁%), forced vital capacity (FVC) and peak expiratory flow were significantly ($p < 0.001$) reduced in the test compared with the control subjects. There were no correlations between the lung function indices and duration in fabric sales. The concentrations of gases (carbon dioxide, oxygen, hydrogen sulphide, ammonia, formaldehyde and total volatile organic compounds) and particulate matter (PM 1.5, Pm 2.5 and Pm 10) in the ambient air of fabric shops and control sites were not significantly different. We therefore conclude that chronic exposure to fabrics could be associated with derangement in pulmonary function indices.

KEYWORDS: Lung function indices, clothes/clothing, dealers

INTRODUCTION

Textile fabric is a material, woven, knitted, tufted or bonded together using natural or synthetic threads, yarns or other materials (Forstater, 2009). As an assortment of textiles, fabrics are used in the fashion industry to create various designs and uses. There are foundationally important in creating silhouette and aesthetics.

Textile manufacturing is based on the conversion of fibres to yarns which are then converted to fabrics like wool, polyester, linen, nylon etc which are then fabricated into different products including home textiles and clothings, important in the clothes or apparel industry (Forstater, 2009; US Bureau of Labor Statistics, 2006).

The global textile industry is a massive and growing market, valued at about one trillion dollars and projected to reach 1.5 Trillion Dollars by 2027 which is an indication of the significant market size for textile products worldwide (Royal Europe Textile, 2025). The industry is said to directly employ well over 60 million people (Forstater, 2019).

Industrial production of textiles and exposure to chemicals used in the process and by-products have long been known to have negative health effects including pulmonary dysfunction on textile workers (Christiani and Wang, 2001; Nagoda et al, 2012; Elshaer et al, 2023, MedlinePlus 2023; Ali et al, 2018).

Aribo, E. O., Department of Human Physiology, University of Calabar, Calabar, Nigeria

Bekeh, E. B., Department of Human Physiology, University of Calabar, Calabar, Nigeria

Utionkpan, L. P., Department of Human Physiology, University of Calabar, Calabar, Nigeria

The impairment is attributed to cotton dust and other particulate matter, volatile organic compounds, formaldehyde, oxides of Sulphur and Nitrogen as well as chemicals used in the production of fabrics (Glover 2021, Rahman et al 2020).

Clothing is one of the three basic needs of humans. The clothing industry, just like the textile, is a huge global industry as the need to strike impression with different and fashionable clothings grows. The garment or clothing manufacturing is the third world's biggest industrial industry directly employing over 60 million people (International Labor Organization, 2015). The world consumes around 80 billion new pieces of clothing every year, 400% more than the consumption twenty years ago (Maiti, 2025).

Finished products of textiles including clothings from which apparels or garments are made, have been reported to contain residual amounts of the chemical bye-products like benzothiazoles, benzotriazoles, aromatic amines etc in substantial amount and these may affect health (Luongo et al 2014, Avagyan et al, 2025). With storage, the chemical contamination of textile products including clothings increases due to release of various chemical substances like volatile organic compounds, phthalates, formaldehyde etc from evaporation and leaching (Furst et al 2025). This may contribute to environmental pollution (Aldegunde-Louzao et al 2024). Indoor air quality is reported to be altered in the retail clothing shops (Furst et al 2025, Licina et al, 2021). Clothings are also reported to serve as transport vectors or reservoir for microbes, particulate matter and chemical pollutants which may be harmful (Licina and Nazoraff, 2018).

Trading in second-hand clothing is a thriving business in Nigeria due to poverty and the low quality of the ones manufactured locally. The poor treatment and handling of this class of textiles is a potential threat to pulmonary health (Ogoe, 2019). Apart from the chemical contaminants in second-hand clothings, they serve as potential sources of transmission of infections with possible respiratory effects (Norris, 2012; International Scientific Forum on Home Hygiene, 2025). Lung function impairment from such exposures have been partly blamed on oxidative stress which is established as a major mechanism for tissue injury following exposure to many chemicals including drugs (Vasquez et al., 2021), which could have explained functional impairments in systems following such exposures (Davies et al, 2013).

From available literature, derangement in lung function is widely reported among textile industrial workers (Nagoda et al., 2012; Elshaer et al., 2023; Luongo et al., 2014; Licina and Nazaroff, 2018). As Finished products of the textile industry like clothes and second-hand clothings are reported to be reasonably contaminated with chemicals and microbes which may cause air pollution and affect pulmonary health.

However, unlike textile workers, there is paucity of information on the pulmonary health indices of traders involved in the sales of finished textile products (clothes and clothings), hence this study.

MATERIALS AND METHODS

Ethical consideration

Ethical approval for the study was obtained from the University of Calabar Teaching Hospital Research Ethics Committee (No. NHREC/07/10/2012).

Study area

The area for this study was Calabar metropolis. Calabar is a cosmopolitan city located in the costal area of the Niger Delta in Southern Nigeria. It is populated by people of diverse ethnic backgrounds.

Study design

This was a cross-sectional study carried out on male clothes/clothing dealers in Calabar metropolis, aged between 20-45 years and who must have spent not less than 2 years in the trading business. The study involved 132 clothes/clothing dealers with same number of control group made up of students and civil servants aged-matched with the test group. Consent was obtained from all participants before being recruited into the study. A structured questionnaire developed from related literature was used to collect the subject's biodata.

Study sample

The study sample was 132 clothes/clothing dealers in our setting computed from Solvin's formula (Yamane, 1967),

$$n = \frac{N}{1 + Ne^2}$$

Where n = sample size,

N = Number of clothes/clothing dealers and e, the error tolerance (level) or confidence level in this case 95%.

A simple random sampling technique was used.

Inclusion criteria

These included males aged between 20-45 years who must have spent a minimum of 2 years in the trade, not living near environmental pollutants like dump sites, no history of cardiopulmonary disease, non-smokers and must be resident in Calabar. Subjects for both control and test groups who did not meet the criteria were excluded.

Measurement of anthropometric parameters

The weight of subjects was measured using a bathroom scale (Camry, China) with subjects on light dressing without shoes. Height of subjects was measured in meters using improved stadiometer with subjects standing on bare feet. The body mass index (BMI) was computed by dividing the weight (Kg) by the square of height (m), while the chest circumference was measured with an in-elastic tape using the nipples as landmarks.

Determination of lung function indices

Lung function was measured spirometrically with a Vitalograph (Alpha touch 600 model, UK) duly calibrated by the manufacturer. The procedure was performed as recommended by the European Respiratory Society (European Respiratory Society, 2012) and described by previous researchers (Moore, 2012; Umoh et al., 2020). An informed consent was obtained from subjects. The procedure was explained and demonstrated to the subjects. The test was done in the standing position with subjects not on tight clothing, collar or tie. A total of three manoeuvres were performed for each subject and the best of the three results taken for the particular subject.

Each subject in turn was asked to breathe in deeply and insert a disposable mouth piece of the Vitalograph into his mouth. Following the deep inspiration, and the nostrils held tight with the thumb and index finger, subjects blew out very fast, sustained and completely as possible into the spirometer and the spirogram extracted.

Statistical analysis

Data obtained from the study were expressed as mean \pm SEM and analyzed using the independent Student t- Test, correlation and regression analysis. Excel was used to produce the charts and scattered diagrams. A p-value of < 0.05 was considered statistically significant.

RESULTS

Comparison of mean ages of control and test groups

The mean ages (years) for control and test subjects were 29.83 ± 0.53 and 29.14 ± 0.43 respectively. There were no significant differences in the ages of both groups as seen in table 1.

Comparison of anthropometric parameters between control and test groups

The mean body weights (Kg) for control and test groups were 66.14 ± 0.41 and 65.61 ± 0.34 respectively. The mean height (m) of the control group was 1.67 ± 0.01 and 1.66 ± 0.01 for the test subjects. For mean body mass index (kg/m^2), the control had 23.78 ± 0.23 while the test group had 23.97 ± 0.18 . The mean chest circumference (cm) were 84.68 ± 0.39 and 84.33 ± 0.33 for control and test groups respectively. There were no significant differences in all anthropometric parameters between the control and test groups as shown in table 1.

Table 1: Comparison of mean age and anthropometric parameters in control and test groups

	Age (Years)	Weight (Kg)	Height (m)	BMI (kg/m^2)	Chest circumference (cm)
Control group	29.83 ± 0.53	66.14 ± 0.41	1.67 ± 0.01	23.78 ± 0.23	266.20 ± 15.23
Test group	29.14 ± 0.43	65.61 ± 0.34	1.66 ± 0.01	23.97 ± 0.19	219.04 ± 1.74

Values are expressed as mean \pm SEM.

No significant differences between control and test groups.

Comparison of FVC between different experimental groups

The mean values of FVC (L) for the control and test groups were 3.37 ± 0.03 and 3.13 ± 0.02 respectively. The FVC was significantly ($p < 0.001$) lower in the test than in the control groups as shown in Fig 1.

Comparison of FEV₁ between the control and test groups.

The mean FEV₁ (L) was significantly ($p < 0.001$) lower in the test (2.07 ± 0.02) than in the control (2.49 ± 0.04) groups, Fig 2.

Comparison of FEV₁% between the control and test groups

The mean \pm SEM of FEV₁% for the control and test groups were 73.68 ± 0.81 and 66.19 ± 0.54 for control and test groups respectively. The result shows a significantly ($p < 0.05$) lower FEV₁% in the test compared with the control groups, Fig 3.

Comparison of peak expiratory flow rate (PEFR) between the control and test groups

The mean values of PEFR (L/min) were 266.20 ± 15.23 and 219.04 ± 1.74 for control and test groups respectively. The PEFR was significantly ($p < 0.01$) lower in the test compared with control groups, Fig 4.

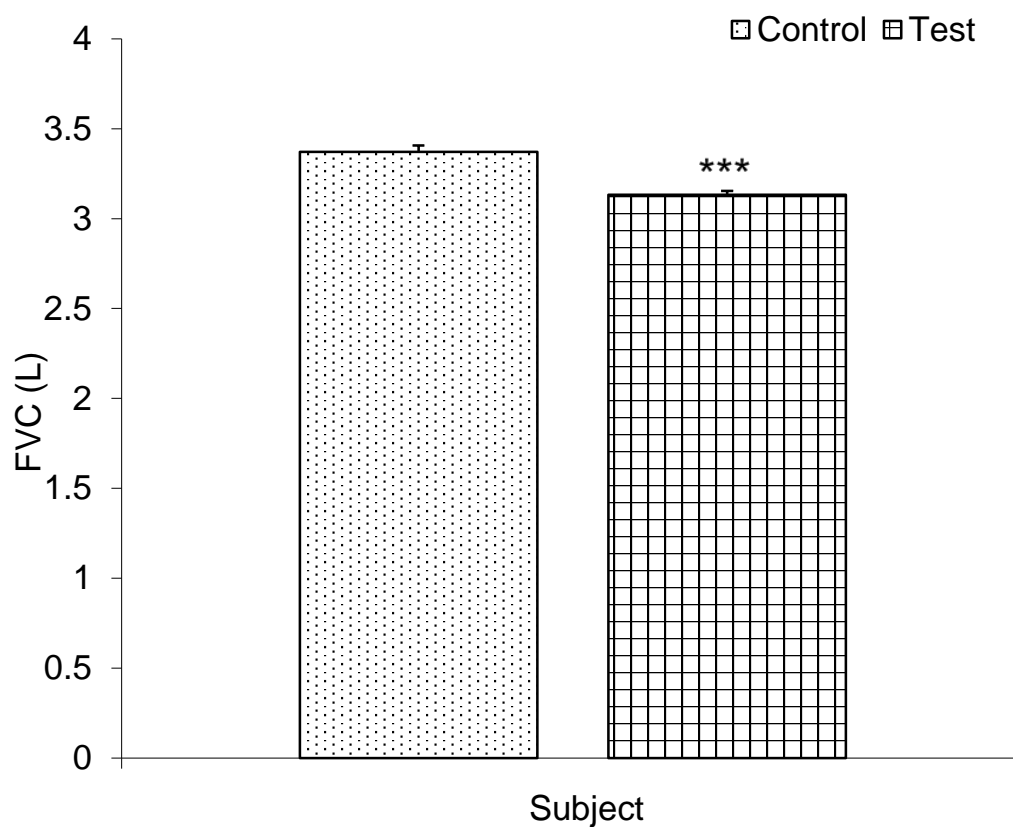


Figure 1: Comparison of forced vital capacity (FVC) of control and textile sellers / dealers.

Values are expressed as mean +SEM, n = 132.

*** = $p < 0.001$ vs control

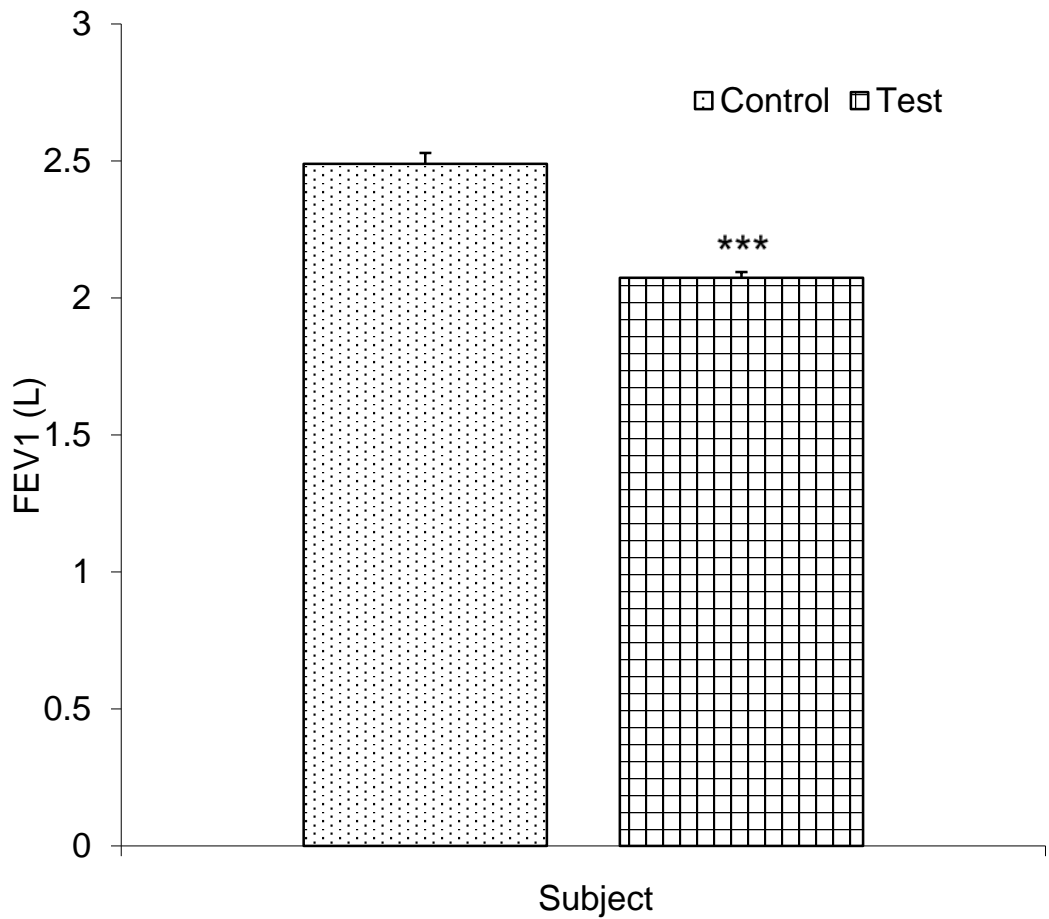


Figure 2: Comparison of forced expiratory volume in one second (FEV1) of control and textile sellers / dealers.

Values are expressed as mean +SEM, n = 132.
*** = p<0.001 vs control

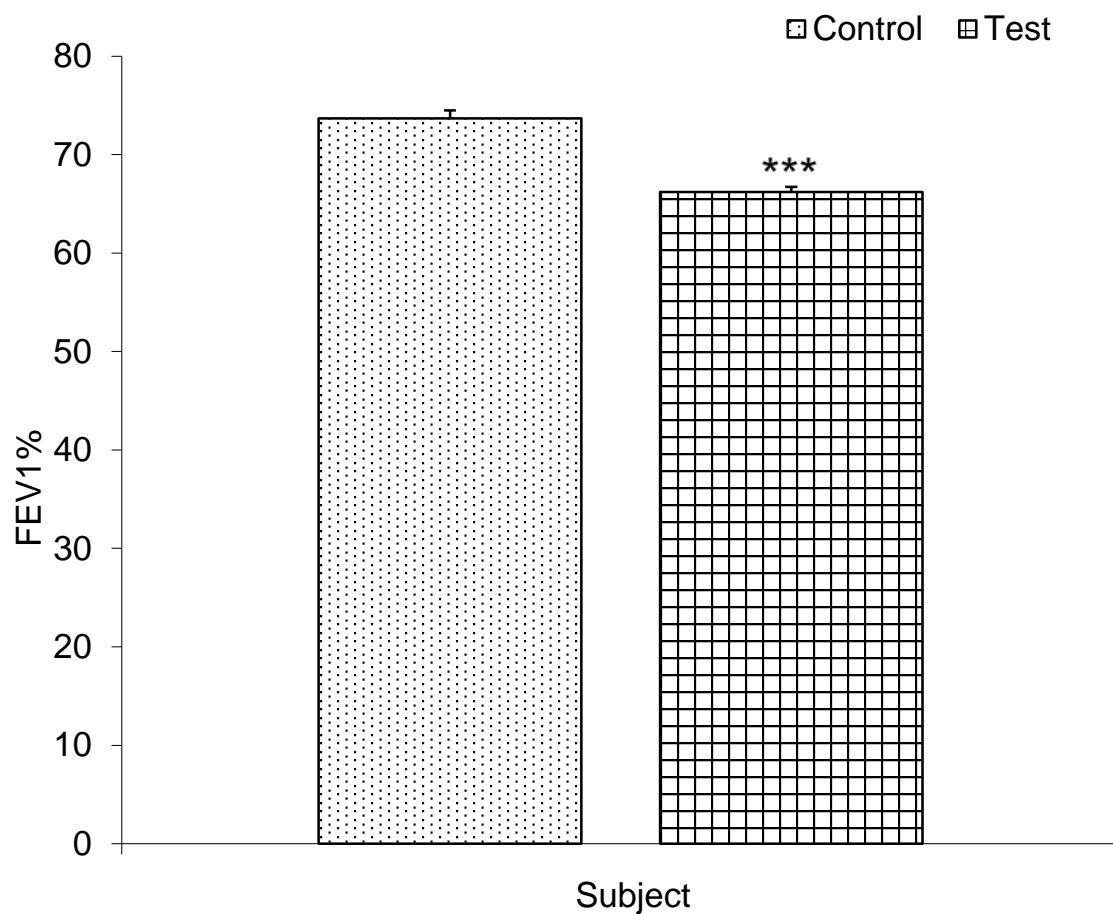


Figure 3: Comparison of forced expiratory volume in one second percent (FEV1%) of control and textile sellers / dealers.

Values are expressed as mean +SEM, n = 132.

*** = $p < 0.001$ vs control

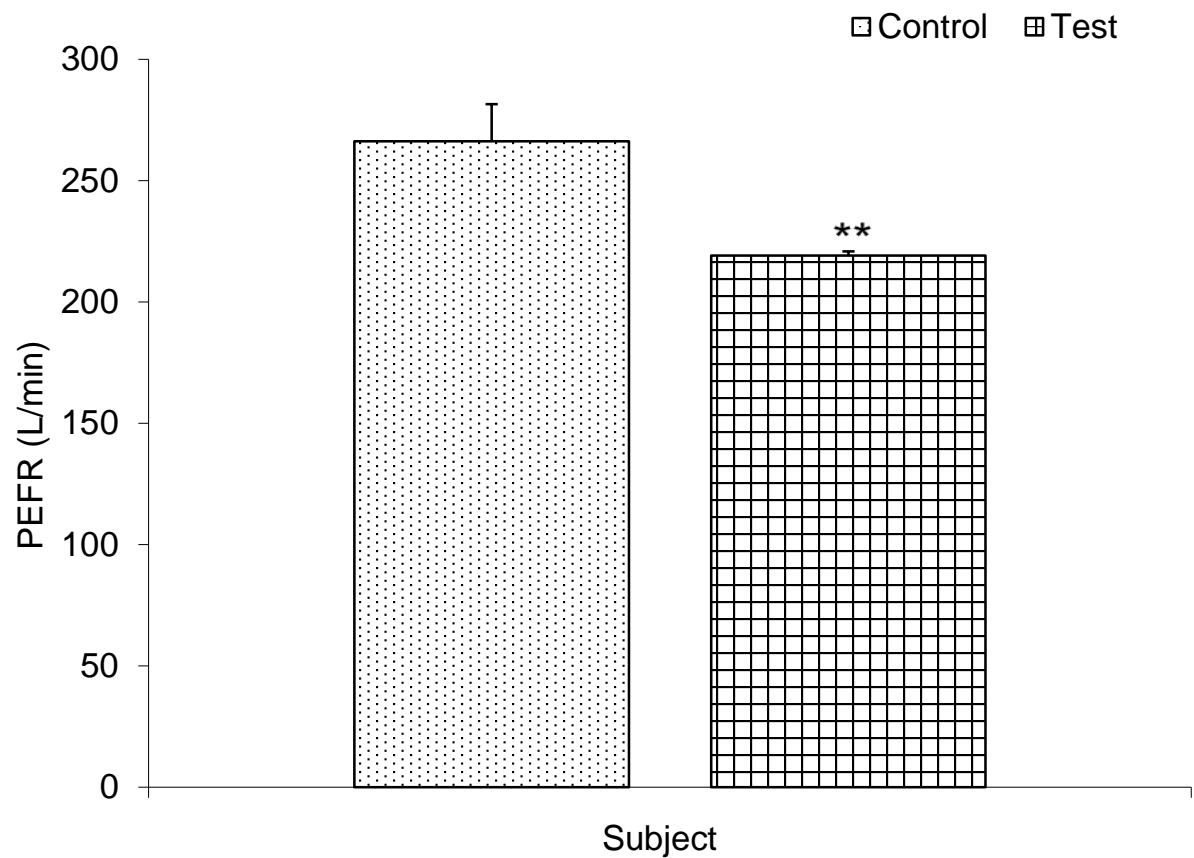


Figure 4: Comparison of peak expiratory flow rate (PEFR) of control and textile sellers / dealers.

Values are expressed as mean +SEM, n = 132.
** = p<0.01 vs control

Correlation of FVC, FEV₁, FEV₁% and PEFR and duration of service.

There were negative but non-significant relationships between FVC, FEV₁, FEV₁% or PEFR

and duration of trading in the sales of clothes/clothings. These are shown in Figs 5,6,7 and 8.

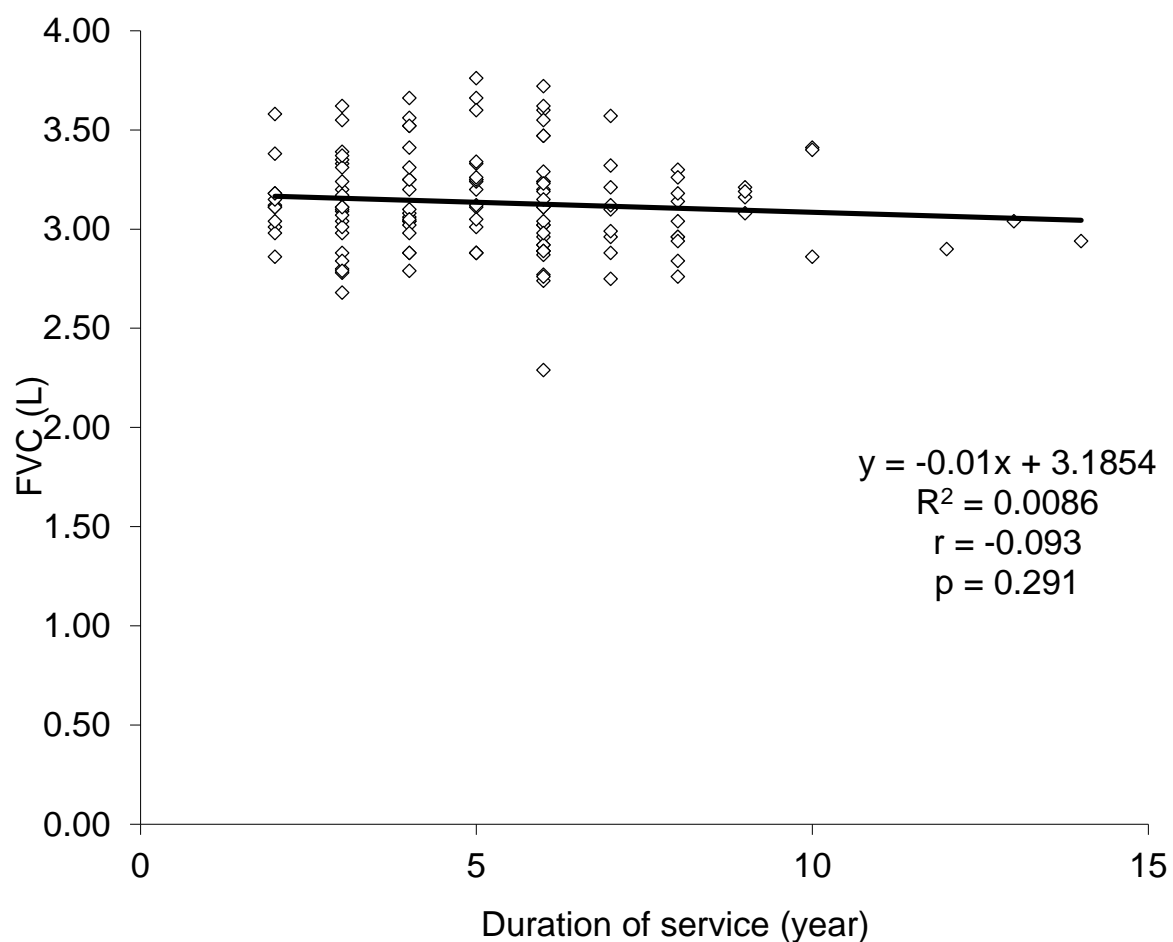


FIG 5: Relationship between forced vital capacity and duration of service

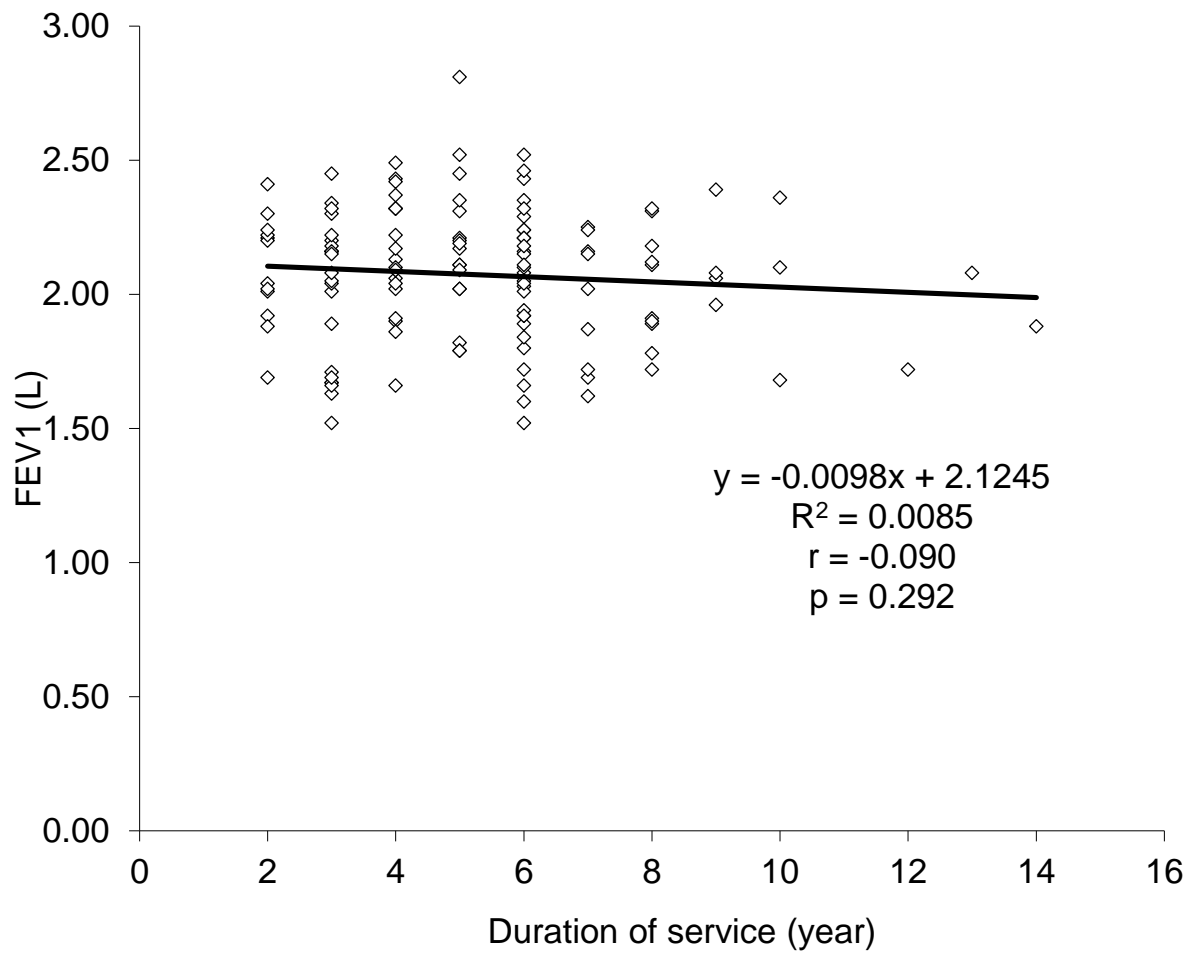


FIG.6: Relationship between forced expiratory volume and duration of service

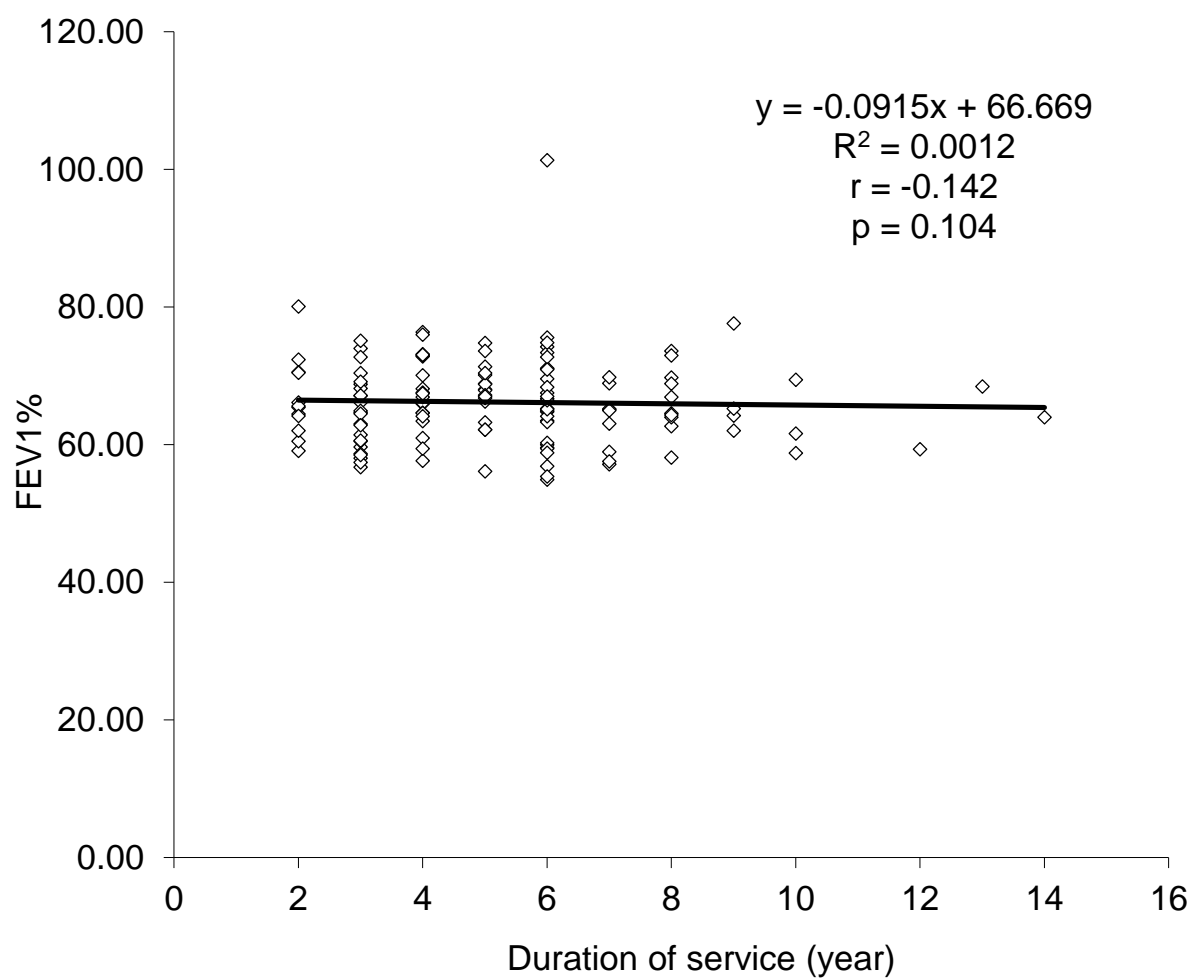


FIG.7: Relationship between forced expiratory volume in one second percent (FEV1%) and duration of service

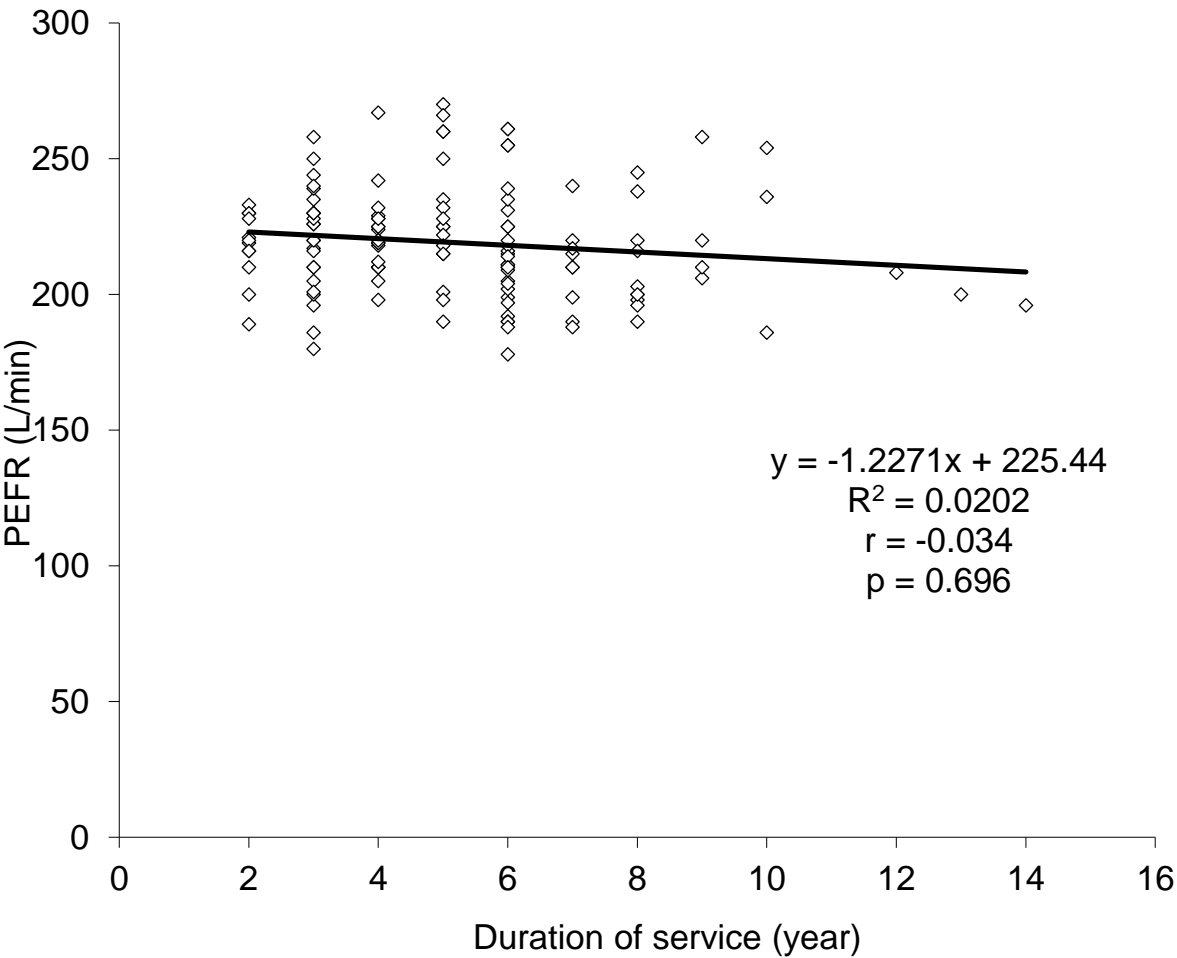


FIG.8: Relationship between peak expiratory flow rate (PEFR) and duration of service

Comparison of concentration of particulate matter in test and control sites.

The mean values for Pm 1.0 for the test and control sites were 18.00 ± 0.58 and 17.75 ± 1.18 respectively. For particulate matter Pm 2.5, the values were 26.50 ± 0.29 and 29.25 ± 1.60 for control and test sites respectively. Mean values of Pm 10.0 for the control sites was 29.00 ± 5.82 and 36.75 ± 2.50 for the test sites. There were no significant differences in the concentrations of particulate matter in the control and test sites as seen in table 2.

Comparison of gases in the ambient air of test and control sites.

The mean values of O₂ (PPM) were 20.90 ± 0.00 and 20.75 ± 0.12 for control and test sites respectively. For CO₂ (PPM), the values were 0.04 ± 0.06 and 0.04 ± 0.00 for control and test sites respectively while the values for humidity (PPM) were 61.50 ± 6.38 and 72.25 ± 3.54 for control and test sites respectively. The values for total volatile organic compounds (TVOCs) (mg/m³) were 0.05 ± 0.01 and 0.33 ± 0.14 for control and test sites respectively, while for formaldehyde, the values were 0.11 ± 0.04 and 0.06 ± 0.02 for control and test sites respectively. There were no significant differences in the concentrations of these gases in both control and test sites as shown in table 3.

Table 2: Mean values of particulate matter in control and test sites

	1.0	PM 2.5	10.0
Control site	18.00 ± 0.58	26.50 ± 0.29	29.00 ± 5.82
Test site	17.75 ± 1.18	29.25 ± 1.60	36.75 ± 2.50
p vs control	0.855	0.142	0.267

Values are expressed as mean \pm SEM, n = 3.

No significant differences between control and test sites

Table 3: Mean values of gases and atmospheric compositions in control and test sites

	O ₂ (PPM)	CO ₂ (PPM)	Hum. (PPM)	TVOC (mg/m ²)	HcHO
Control site	20.90 ± 0.00	0.40 ± 0.00	61.50 ± 6.38	0.05 ± 0.01	0.11 ± 0.04
Test site	20.75 ± 0.12	0.40 ± 0.00	72.25 ± 3.54	0.33 ± 0.14	0.06 ± 0.02
P vs control	0.24	NA	0.191	0.091	0.365

No significant differences among groups

NA = not applicable

Nitrogen (iv) oxide, hydrogen sulphide, ammonia, Carbon monoxide and methanol were not detected in both sites.

TVOC = total volatile organic compound

HcHO = formaldehyde

DISCUSSION

Workers in textile mills have been known to have impaired pulmonary function which is attributed to exposure to gases, chemicals and particulate matter from the mills (Christiani and Wang 2001; Glover 2021; Rahman et al., 2020). It is also documented that textile products like clothes and clothing especially if stored retain some of the original particulate or chemical contaminants from the factory or even emit some due to leaching and evaporation aside contributing as reservoirs of microbes (Furst et al., 2025; Aldegunde-Louzao et al., 2024). But the effect of exposure to these textile products (Clothes/clothings) is not well documented and hence this study. Our findings are thus discussed.

Spirometry is a simple and non-invasive method of evaluating pulmonary function (Moore, 2012; Umoh et al., 2020; Urom et al. 2015). Lung function indices are influenced by many physiological factors including age, gender, height, weight, BMI, chest circumference and ethnicity (Talamino et al., 2020; Hall and Hall. 2023). Our findings of non-significant differences in anthropometric parameters (weight, height, BMI, chest circumference) and age between the control and test subjects therefore indicate that any differences in pulmonary function indices between the two groups are not due to any of these factors.

Forced expiratory volume in the first second was significantly reduced in the test or exposed compared with the control groups. This impaired lung function parameter could be caused by the effects of residual chemicals, textile dust and gases which themselves are known to impact negatively on pulmonary health (Nagoda et al., 2012; Luongo et al., 2014). The FEV₁ is a measure of the volume of air exhaled in a second and may be reduced in both obstructive and restrictive pulmonary diseases (Sanja et al., 2021).

The forced vital capacity (FVC) was observed to have been significantly lower among the traders than in the control group. Studies have implicated exposure to textile dust, volatile organic compounds and other chemicals in the reduced FVC observed in workers in textile mill (Glover, 2021; Rahman et al., 2020).

The decrease in FVC among clothes/clothing traders observed in this study can therefore be rightly attributed to their exposure to residual dust, volatile organic compounds (VOC) and other chemicals on these textile products, those produced from clothings during storage as well as microbes from these products (Furst et al., 2025; Aldegunde-Louzao et al., 2024). Forced vital capacity as an index of pulmonary function may be normal or reduced in obstructive lung diseases. It may be reduced also in restrictive patterns of pulmonary diseases (Sanja et al., 2021).

The decrease in FEV₁% among clothes/clothing traders noted in this study is another indication that prolonged exposure to clothes/clothings could impair pulmonary function likely from substances emitted from these products (Avagyan et al., 2025). Forced

expiration volume in one second as a percentage of FVC (FEV₁%), is decreased in obstructive pulmonary disorders but normal or increased in the restrictive type of pulmonary diseases (Tietze, 2012).

The peak expiratory flow was significantly reduced in the test subjects, an indication of impairment in pulmonary function in the test subjects (Hall and Hall, 2023).

Functionally, impairment in lung function may be obstructive, restrictive or a mixed type. Our finding of decreases in FEV₁, FVC, FEV₁% and PEFR in the test subjects suggests that the impaired pulmonary function in our subjects is of the obstructive type (Hall and Hall, 2024, Sanja et al., 2021; Tietze, 2012).

There were no relationships between FVC, FEV₁, FEV₁% and PEFR and duration of trading in the product. Studies on lung function among textile industry workers had shown a positive correlation between duration of exposure and respiratory impairment (Tageldin et al., 2017; OO et al., 2021). The reason for the difference in results might have been due to possible differences in levels of concentration of evaluates in the two settings.

Our findings did not reveal any significant differences in the concentrations of gases and particulate matter between test and control sites. Furst et al., (2025) and Licina et al., (2021), reported an increase in the concentration of particulates, gases and chemicals in the ambient environment of retail textile shops. The differences in observations could be attributed to the period of the year or season when the samples or analyses were done. The gas/dust sampling was done in July, 2024. Concentration of gases, particulate matter and other substances in ambient air is influenced by weather or season since these affect their aerodynamics (World Health Organization, 1999; Hoseinifer et al., 2023; Airly, 2025; Airsset, 2025).

CONCLUSION

We therefore conclude that chronic exposure to clothes/clothings impair lung function which is of the obstructive type and so, could be considered a factor in the etiopathogenesis of pulmonary dysfunctions.

Conflict of interest: The authors declare that, there are no competing interests.

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