National Journal of Physiology, Pharmacy and Pharmacology

RESEARCH ARTICLE

A comparative study of pulmonary function tests in different age groups of healthy people and poultry farm workers in Ludhiana city

Manpreet Kaur Taluja[1], Vidushi Gupta[2], Garima Sharma[2], Jaspreet Singh Arora[3]

[1]Department of Physiology, Netaji Subhash Chandra Bose Medical College, Jabalpur, Madhya Pradesh, India, [2]Department of Physiology, Dayanand Medical College, Ludhiana, Punjab, India, [3]Department of Animal Biotechnology, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

Correspondence to: Manpreet Kaur Taluja, E-mail: drmanpreet17@gmail.com

Received: August 26, 2018; **Accepted:** September 13, 2018

ABSTRACT

Background: The air in poultry farms is strongly contaminated with organic, inorganic, and microbial contaminants. Constant exposure to this environment can induce various symptoms and respiratory changes. The most important determinants of lung functions are age. Respiratory muscle strength decreases with age and can impair effective cough, which is important for airway clearance. Pulmonary function tests provide a better understanding of functional changes in the lungs. **Aims and Objectives:** This study aims to compare the various pulmonary function parameters in various age groups in poultry farm workers and healthy controls. **Materials and Methods:** Pulmonary function tests were done using computerized autospirometer. The study was carried on 132 subjects (66 each). They were grouped according to their age (18–30 years, >30–40 years, >40–50 years, and >50–60 years). Data were analyzed using Student's *t*-test, one-way ANOVA, and *post hoc* by Bonferroni test. **Results:** We found that in healthy controls and poultry workers, there was statistically significant ($P < 0.05$) decrease in forced expiratory volume (FEV)-0.5, FEV1, FEV3, forced expiratory flow (FEF) 50%, FEF 75%, and maximum voluntary ventilation with age. In addition, there was statistically significant ($P < 0.05$) decrease in FEF 0.2–1.2, peak expiratory flow rate (PEFR), FEF25%, and FEV1/forced vital capacity (FVC) in poultry workers. However, when poultry workers were compared to controls, FVC, FEV0.5, FEV1, FEV3, FEF0.2–1.2, FEF25%, and PEFR were found to be significantly ($P < 0.05$) decreased. **Conclusion:** Differences in respiratory pattern in poultry farm workers suggest that poultry dust has additional deteriorating effect on lung functions along with impact of age. Hence, there is a need to increase awareness about harmful effects of poultry dust and the use of personal protective equipment.

KEY WORDS: Poultry Farm Workers; Poultry Dust; Pulmonary Function Tests; Age Groups

INTRODUCTION

Poultry farm workers work predominantly in indoor buildings. These are close off on all sides and crowded buildings. Great amount of poultry dust, various gases, microbes, and their microbial metabolites originate from the poultry birds, their waste products which have the capacity to cause health deterioration in the exposed humans.[1]

Access this article online	
Website: www.njppp.com	Quick Response code
DOI: 10.5455/njppp.2018.8.0928113092018	

Depending on the activity on poultry farms following buildings are needed - Hatchery - it is a place where artificial incubation of eggs is undertaken by machines for the production of chicks. The size of hatchery varies from a few hundred eggs capacity to several million eggs. Brooder house - it is the place where temperature is maintained both in hot and cold weather for brooder birds. Broiler house - it is the place where chicken are reared for production of meat. Here, day-old chicks are procured and kept them for around 6 weeks. Layer house - it is the place where eggs are laid by the laying birds. Poultry processing unit - it comprises receiving, hanging, slaughtering area, defeathering, eviscerating, packaging, refrigeration room, and disposal area. Feed mill - it is used for preparation and uniform mixing of feed for poultry.[2]

The work environment in which the poultry farm workers are occupationally exposed consists of dust particles, feathers, dander, feed, litter, endotoxins, bacteria, fungi, and molds. Harmful gases in poultry confinement buildings are carbon dioxide (CO_2) - the CO_2 arises from the regular breathing of the birds. The CO_2 content is used to measure the potency of movement of air between the environment and the lungs through inhalation and exhalation. Ammonia (NH_3) - NH_3 is a byproduct of fermentation processes of bacteria in the manure. The NH_3 content of the poultry environmental air is dependent on ventilation, temperature of the building, amount of water vapor presents in the air, and the number of stock per hectare. The NH_3 when present in large amount causes the irritation of the mucous membranes.

Hydrogen sulfide (H_2S) - H_2S is one of the most important gases arising from the storage, handling, and putrefaction of poultry waste. When the manure is blended or taken out from the pit, the H_2S is released into the environment. Even meager amount of H_2S is dangerous to health as it is both an irritant to the tissues and an asphyxiant. The main method of absorption of H_2S is by inhaled air. It attaches to cytochrome oxidase, a mitochondrial enzyme and thus causing blockage of process of oxidative phosphorylation and energy production. This results in anerobic metabolism and hence lactic acidosis. Carbon monoxide (CO) - it is an odorless, very harmful gas. It originates from partial combustion due to deficiency of oxygen (O_2) in gas heaters (clean filters). Sulfur dioxide (SO_2) - SO_2 originates when fuel used is oil. Less SO_2 is formed from clean oil.

Poultry farm workers spend most of their time in their work environment. Chronic exposure to this environment makes them more susceptible to respiratory health hazard. Concentrated animal feeding operations (CAFOs) are considered important due to their influence on human health, the surrounding environment, and the quality of life in the residing areas in which they are located. The odor linked with CAFOs has an ill effect on health status of the individual.[3-5]

Spirometry has many indications such as diagnostic - to reason out the symptoms, signs, or not normal laboratory tests report, to evaluate the impact of disease on lung function, to screen the individuals who are prone to developing pulmonary disease, to recognize pre-operative risk, and to find out the health state before beginning of strenuous exercise programs; monitoring - to carry out therapeutic intervention, to describe the outcome and pathway of diseases that affect the functioning of lungs, and to assess health status of affected individuals exposed to injurious agents or side effects to drugs with known lung toxicity; disability/impairment evaluations - to assess the affected individual's patients as part of a rehabilitation program, insurance estimation, and for legal reasons; and public health - planning and conducting a survey, deduction of reference equations, and clinical research.[6,7] Hence, poultry farm workers are at risk of developing respiratory dysfunction which can be assessed at an early stage using spirometry.

The most important determinants of lung functions are as follows:

Age

Younger adults have higher lung function.[8] Pulmonary function increases up to the middle twenties and then decrease with age as static recoil pressure of the lungs decreases, leading to decline in flow rates, especially forced expiratory flow (FEF) and vital capacity.[9] In old age, there is decrease in lung compliance, increase in airway resistance and reduction in the capacity of muscles of respiration and decrease in the elastic recoil of the lung, and increase in stiffness of thoracic cage. The respiratory muscle strength declines as the age increases and can hinder effective cough mechanism, which is essential for airway clearance.[10]

Height

Standing height is an important correlating variable. Tall persons have greater lung function.[8] Irrespective of the age, there is positive correlation of the vital capacity with height because taller individual has greater alveoli, and therefore, the total lung volume is more. During the growth spurt, occurring in children and adolescents, the increase in height is more and peaks approximately 1 year before as compared to lung growth.[6,7,11]

Sex

Female's candidates having similar age and height as males have slightly lower pulmonary function.[8] The main reason for this may be due to more muscular strength of males.[12] Males have larger, more number of alveoli per unit area and also have high compliance as compared to female.[13] Ethnicity - Indian population demonstrate a lower vital capacity as of Caucasians.[12,6,7] Reason being Caucasians is taller and has larger lung volumes.[12]

Body Surface Area (Bsa)

The well-balanced actions between various respiratory muscles determine the lung functions in human body. They are influenced by the thickness of the diaphragm muscle and BSA. The greater the diaphragm muscle thickness and higher the BSA, better is the lung function. There is a positive correlation in lung function variables and BSA.[13,14]

The various lung function parameters detected by spirometer are as follows:

Forced Vital Capacity Fvc (L)

It is the maximal amount of air that can be forcibly exhaled from the lungs from the point of maximal inspiration expressed in liters at body temperature and ambient pressure saturated with water vapor at BTPS.[7] It is used to measure the presence and severity of lung disease.[15] FVC decreases in conditions in which there is obstruction to the airways resulting in air trapping, for example, bronchial asthma.[16]

Forced Expiratory Volume (Fev) In ½ S (L)

It is the highest amount of air exhaled in the first ½ s of a forced expiration from the point of maximum inspiration.

Fev In 1 S (L)

It is the expired in the 1st s of a forceful expiration from a point of maximal inspiration. FEV_1 is an important test to know generalized airway obstruction. As it is effort dependent, it should be performed properly to get the appropriate result. It is lowered in conditions of lung obstruction, for example, bronchial asthma.[16]

Fev In 3 S (L)

It is the highest amount of air expired in 3 s of a forced expiration from a point of maximal inspiration.

Fef At 25%, 50%, And 75% (L/S)

It is FEF when 25%, 50%, and 75% portion of the FVC has been expired, respectively.

Fef Between 25% And 75% (L/S)

The average FEF ranges from 25% to 75% of the FVC.[7,8] This represents patency of small airways and is considered a good test to detect early small airway obstruction.[14,16]

Fef Between 0.2 And 1.2 L

This is the flow rate between 200 ml and 1200 ml of FVC. It is one of the sensitive indicators of patency of large airways. It is slowed in large airway obstruction.[16,17]

Fev (Timed) To Fvc Ratio

It expressed in percent (%) - $FEV_{O.5}$/FVC, $FEV_{1.0/}$FVC, $FEV_{3.0/}$FVC. The ratio of FEV_1/FVC is approximately 0.75–0.80. This is more sensitive indicator of airway obstruction than FVC or FEV_1 alone.[16] FEV_1/FVC can be used to differentiate between various types of diseases. For instance, in obstructive lung disease like asthma both the values FEV_1 and FVC are declined, but FEV_1 is lowered more as compared to FVC. In fibrosis of lung which is a restrictive lung disease, both the values are decreased, but FEV_1 is lowered less as compared to FVC. Thus, in fibrosis, FEV_1/FVC actually increases.[18]

Maximum Voluntary Ventilation (Mvv) (L/Min)

It is the total amount of air that can be moved into and exhaled out of the lungs during one full minute. It is measured for 15 s period and extrapolated for a minute; normal values extend between 140 and 180 L/min in healthy adult males.[15] MVV decreases in patients with subjective dyspnea.[16]

Since very few studies have been done on poultry farm workers, so this study was done with the aim and objectives to compare the various pulmonary function parameters in various age groups in poultry farm workers and healthy controls and to find out the correlation of pulmonary function tests with anthropometric variables in poultry farm workers.

MATERIALS AND METHODS

The Institutional Ethics Committee of Dayanand Medical College and Hospital, Ludhiana, Punjab, India, gave approval to the study and consent forms. Informed consent was taken for data collection. A cross-sectional study of poultry farm workers and comparison groups of healthy non-exposed groups was conducted in Ludhiana city.

In total, 66 poultry farm workers between the age of 18 and 60 years and 66 healthy control subjects participated in the study. Exclusion criteria were a history of any respiratory and cardiovascular disease, smoking, had recent surgery, and unwilling to participate. Those who agreed to take part in the study filled a pro forma containing name, age, sex, address, normal hours of work, and years of work. A detail history taking, general physical examination and systemic examination were done and the following anthropometric parameters were noted.

Age was noted in completed year. The subjects were grouped according to their age,
Group A: 18–30 years
Group B: >30–40 years
Group C: >40–50 years
Group D: >50–60 years.

Body height in centimeters (cm) - subjects height was taken in upright position without shoes with arms at their sides, heels together, toes apart and back of the head, shoulder blades, buttocks, and heels making contact with the backboard.[19]

Body weight nearest to 0.1 kg was measured in kilograms (kg) by standard weighing machine.

BSA in m^2 by DuBois and DuBois[20] BSA = $(W^{0.425} \times H^{0.725}) \times 0.007184$, where the W is weight in kilograms and H (height in centimeters).

Body mass index (BMI) kg/m^2 was calculated by Quetelet index.[21]

BMI=Weight in kg/(height in meters)^2

Pulmonary function tests - spirographic variables of FVC, $FEV_{0.5}$, FEV_1, FEV_3, $FEF_{25-75\%}$, $FEF_{0.2-1.2}$, $FEF_{25\%}$, $FEF_{50\%}$, $FEF_{75\%}$, $FEV_{O.5}$/FVC, $FEV_{1.0}$/FVC, and $FEV_{3.0}$/FVC were measured using a computerized autospirometer (Helios 701: Chandigarh). Maneuvers were done in accordance to the American Thoracic Society criteria.[6,7,11] All tests were done in standing posture with usage of a nose clip. Technicians were trained in spirometry at the Dayanand Medical College before the study.

Statistical analysis - data collected on variables were statistically done by IBM SPSS Statistics Version 20. One-way ANOVA and *post hoc* by Bonferroni were applied for the intragroup comparison within various age subgroups. Student's *t*-test was applied to compare the means of control and study groups in different age subgroups. Pearson's correlation coefficient test was used to correlate between the anthropometric parameters and the pulmonary function parameters. $P < 0.05$ was taken as statistically significant and $P < 0.001$ as highly statistically significant.

Table 1: Age-wise distribution of controls and poultry workers

Age (years)	*n*=66 (%)	
Groups	Controls	Cases (poultry workers)
A 18–30	38 (57.50)	38 (57.50)
B>30–40	14 (21.20)	14 (21.20)
C>40–50	8 (12.00)	8 (12.00)
D>50–60	6 (9.00)	6 (9.00)
Total	66 (100)	66 (100)

RESULTS

The findings of the present study are depicted in Tables 1–9.

DISCUSSION

Comparison of anthropometric parameters in cases (poultry farm workers) and controls has been shown in Tables 2 and 3. We found that in healthy controls and poultry farm workers, there was statistically significant ($P < 0.05$) decline in $FEV_{0.5}$, FEV_1, FEV_3, $FEF_{50\%}$, $FEF_{75\%}$, and MVV with age [Tables 4,5]. In addition, a statistically significant ($P < 0.05$) decline in $FEF_{0.2-1.2}$, peak expiratory flow rate (PEFR), $FEF_{25\%}$, and FEV_1/FVC was observed in poultry workers [Table 6]. However, when poultry workers were compared to controls, FVC, $FEV_{0.5}$, FEV_1, FEV_3, $FEF_{0.2-1.2}$, $FEF_{25\%}$, and PEFR were found to be significantly ($P < 0.05$) decreased [Table 7].

We also observed a statistically significant positive ($P < 0.05$) correlation with height in controls in FVC, FEV_1, FEV_3, $FEF_{25-75\%}$, $FEF_{0.2-1.2}$, PEFR, and MVV due to higher volume of lungs and more muscular efforts seen in tall individuals[6,22,23] [Table 8]. However, a non-significant negative correlation with weight and BSA in FEV_1, FEV_3, PEFR, and MVV in poultry farm workers except FEV_1/FVC that showed significant negative ($P < 0.05$) correlation. In controls, there was significant positive ($P < 0.05$) correlation with BSA in FVC, $FEV_{0.5}$, FEV_1, and FEV_3[14,24] [Table 9]. There was non-significant negative correlation with BMI in controls. $FEV_{0.5}$, $FEF_{25-75\%}$, $FEF_{50\%}$, $FEF_{75\%}$, FEV_1/FVC, and FEV_3/FVC showed significant negative ($P < 0.05$) correlation with BMI in poultry workers because of added effect of poultry dust on pulmonary functions[25-28] [Table 9].

Table 2: Comparison of anthropometric profile in cases (poultry workers) and controls

Parameters	*n*	Age		Weight	
		Cases	Controls	Cases	Controls
Age groups					
A 18–30	38	25.08±0.596	22.02±0.462	57.50±1.651	69.57±1.938
B>30–40	14	36.14±0.811	36.21±0.664	60.93±2.274	74.85±4.262
C>40–50	8	45.12±0.581	44.62±0.865	58.75±2.2469	76.25±5.164
D>50–60	6	55.50±1.176	53.33±0.667	61.16±4.908	69.16±4.826
Overall		32.62±1.314	30.62±1.394	58.712±1.183	71.469±1.622
ANOVA *P* value		*P*=0.000	*P*=0.000	*P*=0.638	*P*=0.408
Post hoc by Bonferroni		A versus B *P*=0.000, A versus C *P*=0.000, A versus D *P*=0.000			

Values are shown in Mean±SEM. One-way ANOVA with *post hoc* Bonferroni test is used. $P < 0.05$ statistically significant, SEM: Standard error of the mean

Table 3: Comparison of anthropometric profile in cases (poultry workers) and controls

Parameters	*n*	Height		BSA	
		Cases	Controls	Cases	Controls
Age groups					
A 18–30	38	166.74±1.449	169.47±1.195	1.637±0.272	1.796±0.026
B >30–40	14	163.21±0.995	165.50±2.021	1.653±0.030	1.817±0.052
C >40–50	8	167.00±2.113	161.00±3.489	1.656±0.036	1.801±0.077
D >50–60	6	161.33±2.275	166.50±1.996	1.640±0.073	1.769±0.063
Overall		165.530±0.940	167.33±0.977	1.643±0.018	1.798±0.021
ANOVA *P* value		*P*=0.229	*P*=0.030	*P*=0.980	*P*=0.952
Post hoc by Bonferroni		A versus C *P*=0.033			

Values are expressed as mean±SEM. One-way ANOVA with *post hoc* Bonferroni test. $P < 0.05$ statistically significant, BSA: Body surface area, SEM: Standard error of the mean

Table 4: Intragroup comparison of lung function parameters with age (years) in controls

Age groups (years)	*n*	FVC (L)	$FEV_{0.5}$ (L)	FEV_1 (L)	FEV_3 (L)	$FEF_{50\%}$ (L/s)	$FEF_{75\%}$ (L/s)	MVV (L/min)
A (18–30)	38	3.66±0.111	2.87±0.084	3.51±0.105	3.64±0.110	6.14±0.255	3.53±0.224	138.71±3.820
B (>30–40)	14	3.22±0.084	2.42±0.093	2.99±0.086	3.19±0.082	5.04±0.344	2.89±0.349	110.50±4.759
C (>40–50)	8	2.85±0.193	2.28±0.136	2.70±0.183	2.84±0.195	4.76±0.419	2.67±0.424	116.75±8.481
D (>50–60)	6	2.76±0.109	2.08±0.136	2.54±0.136	2.72±0.124	4.01±0.679	1.83±0.348	108.83±13.481
ANOVA		0.000*	0.000*	0.000*	0.000*	0.002*	0.018*	0.000*
Post hoc by Bonferroni		A versus. C *P*=0.004, A versus. D *P*=0.005	A versus. B *P*=0.014, A versus C *P*=0.010, A versus D *P*=0.001	A versus. B *P*=0.022, A versus C *P*=0.002, A versus D *P*=0.001	A versus. C p=0.004, A versus D *P*=0.004	A versus. D *P*=0.011	A versus. D *P*=0.026	A versus. B *P*=0.002, A versus C *P*=0.031

Values are shown as mean±SEM. One-way ANOVA with *post hoc* Bonferroni test. $P < 0.05$ statistically significant, MVV: Maximum voluntary ventilation, FEV: Forced expiratory volume, FVC: Forced vital capacity, FEF: Forced expiratory flow, SEM: Standard error of the mean

Table 5: Comparison of various pulmonary function parameters with age (years) in poultry workers

Age groups (years)	*n*	FVC (L)	$FEV_{0.5}$ (L)	FEV_1 (L)	FEV_3 (L)	$FEF_{50\%}$ (L/s)	$FEF_{75\%}$ (L/s)	MVV (L/min)
A (18–30)	38	2.89±0.119	2.25±0.087	2.79±0.114	2.89±0.119	5.13±0.242	3.36±0.217	109.95±4.395
B (>30–40)	14	2.29±0.177	1.51±0.123	2.09±0.139	2.25±0.150	3.27±0.355	1.93±0.227	79.29±4.181
C (>40–50)	8	2.64±0.240	2.11±0.185	2.53±0.224	2.64±0.240	4.61±0.644	2.68±0.377	98.25±6.427
D (>50–60)	6	2.06±0.233	1.56±0.184	1.86±0.249	2.04±0.220	2.49±0.509	1.36±0.229	74.17±15.924
ANOVA		0.010*	0.000*	0.001*	0.005*	0.000*	0.000*	0.000*
Post hoc by Bonferroni		A versus. B *P*=0.049	A versus B *P*=0.000, A versus D *P*=0.020	A versus B *P*=0.006, A versus D *P*=0.010.	A versus B *P*=0.024, A versus D *P*=0.038	A versus B *P*=0.001, A versus D *P*=0.001	A versus B *P*=0.001, A versus D *P*=0.001	A versus. B *P*=0.002, A versus. D *P*=0.013

Values are shown as mean±SEM. One-way ANOVA with *post hoc* Bonferroni test. $P < 0.05$ statistically significant, FEV: Forced expiratory volume, FVC: Forced vital capacity, FEF: Forced expiratory flow, MVV: Maximum voluntary ventilation, SEM: Standard error of the mean

Our results have demonstrated a significant difference with age in lung function parameters between poultry farm workers and control subjects. Significant decline in pulmonary function parameters has also been reported by many studies. [22,24,29] Senthilselvan *et al.* concluded that swine workers and grain farmers are prone to accelerate yearly losses in lung function, and there was risk for the development of chronic airflow limitation.[25] Oyarzun also reported that the lung parameters, namely FVC, FEV_1, FEV_1/FVC, PEFR, $FEF_{25–75\%}$ and MVV, decrease with age.[26,30,31]

The strength of this study was that a detailed age-wise elaboration has been done on lung status of poultry farm workers in Ludhiana city. However, more research can be done on this aspect of occupational disease in poultry farm

Table 6: Comparison of various pulmonary function parameters with age (years) in poultry workers					
Age groups (years)	***n***	**$FEF_{0.2-1.20}$ (L/s)**	**PEFR (L/s)**	**$FEF_{25\%}$ (L/s)**	**FEV_1/FVC%**
A (18–30)	38	5.66±0.246	6.42±0.243	6.13±0.258	96.90±0.779
B (>30–40)	14	3.72±0.394	4.90±0.450	3.97±0.484	93.05±2.252
C (>40–50)	8	5.52±0.707	6.40±0.691	6.19±0.706	96.38±2.371
D (>50–60)	6	2.97±0.761	3.83±0.796	3.38±0.775	89.34±2.783
ANOVA		0.000*	0.001*	0.000*	0.021*
Post hoc by Bonferroni		A versus. B *P*=0.002, A versus. D *P*=0.002, C versus. D *P*=0.027	A versus. B *P*=0.026, A versus. D *P*=0.004, C versus. D *P*=0.030	A versus. B *P*=0.001, A versus. D *P*=0.003, C versus. B *P*=0.029, C versus. D *P*=0.021	A versus. D *P*=0.040

Values are shown as mean±SEM. One-way ANOVA with *post hoc* Bonferroni test. $P < 0.05$ statistically significant, FEV: Forced expiratory volume, FEF: Forced expiratory flow, PEFR: Peak expiratory flow rate, FVC: Forced vital capacity, SEM: Standard error of the mean

Table 7: Comparison of pulmonary function parameters between controls and cases				
Age groups (years)	**A (18–30)**	**B (>30–40)**	**C (>40–50)**	**D (>50–60)**
Number of workers (*n*)	**38**	**14**	**8**	**6**
FVC (L)				
Controls	3.66±0.111	3.22±0.084	2.85±0.193	2.76±0.109
Cases	2.89±0.119*	2.29±0.177*	2.64±0.240	2.06±0.233*
P-value	*P*=0.000	*P*=0.000	*P*=0.508	*P*=0.021
$FEV_{0.5}$ (L)				
Controls	2.87±0.084	2.42±0.093	2.32±0.134	2.08±0.136
Cases	2.25±0.087*	1.51±0.123*	2.11±0.185	1.36±0.233*
P-value	*P*=0.000	*P*=0.000	*P*=0.364	*P*=0.025
FEV_1 (L)				
Controls	3.38±0.129	2.99±0.086	2.70±0.183	2.54±0.136
Cases	2.79±0.114*	2.09±0.139*	2.53±0.224	1.86±0.249*
P-value	*P*=0.000	*P*=0.000	*P*=0.569	*P*=0.038
FEV_3 (L)				
Controls	3.64±0.110	3.19±0.082	2.84±0.195	2.72±0.124
Cases	2.89±0.119*	2.25±0.150*	2.64±0.240	2.04±0.220*
P-value	*P*=0.000	*P*=0.000	*P*=0.535	*P*=0.022
$FEF_{25-75\%}$ (L/s)				
Controls	5.60±0.233	4.48±0.280	4.35±0.428	3.52±0.574
Cases	4.75±0.228*	3.03±0.295*	4.17±0.505	2.23±0.438
P-value	*P*=0.011	*P*=0.001	*P*=0.791	*P*=0.104
$FEF_{0.2-1.2}$ (L/s)				
Controls	7.55±0.302	7.19±0.484	6.31±0.389	6.45±0.790
Cases	5.66±0.246*	3.72±0.394*	5.52±0.707	2.96±0.790*
P-value	*P*=0.000	*P*=0.000	*P*=0.341	*P*=0.010
$FEF_{25\%}$ (L/s)				
Controls	7.95±0.265	6.98±0.608	6.39±0.437	7.03±0.739
Cases	6.13±0.258*	3.97±0.484*	6.19±0.706	3.38±0.775*
P-value	*P*=0.000	*P*=0.001	*P*=0.815	*P*=0.007
PEFR (L/s)				
Controls	8.57±0.281	8.18±0.496	7.71±0.562	8.23±0.718
Cases	6.42±0.243*	4.90±0.450*	6.40±0.691	3.83±0.796
P-value	*P*=0.000	*P*=0.000	*P*=0.165	*P*=0.002

Values are shown as mean±SEM. Student's *t*-test. $P < 0.05$ statistically significant, FEV: Forced expiratory volume, FVC: Forced vital capacity, FEF: Forced expiratory flow, SEM: Standard error of the mean, PEFR: Peak expiratory flow rate

Table 8: Correlation of lung function parameters with anthropometric variables in controls and cases

Parameters	Height				Weight			
	Controls		Cases		Controls		Cases	
	r	*P*	*r*	*P*	*r*	*P*	*r*	*P*
FVC	0.5500***	<0.0001	0.0725	0.5627	0.1805	0.1470	–0.0340	0.7862
$FEV_{0.5}$	0.5098***	<0.0001	0.0421	0.7369	0.1465	0.2405	–0.1011	0.4192
FEV_1	0.5593***	<0.0001	0.0650	0.6036	0.1529	0.2202	–0.0928	0.4586
FEV_3	0.5627***	<0.0001	0.0687	0.5835	0.1865	0.1337	–0.0419	0.7378
$FEF_{25-75\%}$	0.3443*	0.0046	0.0562	0.6537	0.1201	0.3367	0.1112	0.3740
$FEF_{0.2-1.2}$	0.2706*	0.0280	0.0591	0.6373	0.1272	0.3088	0.0719	0.5659
PEFR	0.2928*	0.0171	0.0472	0.7064	0.1594	0.2012	–0.0638	0.6104
$FEF_{25\%}$	0.2506*	0.0424	0.0481	0.7010	0.0769	0.5392	–0.1013	0.4183
$FEF_{50\%}$	0.2839*	0.0209	0.0321	0.7976	0.1773	0.1544	–0.1259	0.3138
$FEF_{75\%}$	0.3018*	0.0138	0.0274	0.8269	0.0996	0.4262	–0.1380	0.2690
$FEV_{0.5}$/FVC%	0.0233	0.8523	–0.0353	0.7783	–0.0326	0.7946	–0.1359	0.2766
FEV_1/FVC%	0.1115	0.3728	–0.0661	0.5974	–0.0684	0.5852	–0.2755*	0.0252
FEV_3/FVC%	0.0857	0.4934	–0.0635	0.6121	0.0688	0.5830	–0.0738	0.5558
MVV	0.4249***	0.0004	–0.0140	0.9108	0.0069	0.9556	–0.1536	0.2183

Values represent *r* value of Pearson correlation coefficient, MVV: Maximum voluntary ventilation, FEV: Forced expiratory volume, FVC: Forced vital capacity, FEV: Forced expiratory volume, FEF: Forced expiratory flow, PEFR: Peak expiratory flow rate

Table 9: Lung function parameters correlated with anthropometric variables in controls and cases

Parameters	BSA				BMI			
	Controls		Cases		Controls		Cases	
	r	*P*	*r*	*P*	*r*	*P*	*r*	*P*
FVC	0.3559*	0.0034	0.0027	0.9823	–0.098	0.4360	–0.086	0.492
$FEV_{0.5}$	0.3068*	0.0122	–0.0618	0.6217	–0.119	0.3420	–0.250*	0.043
FEV_1	0.3318*	0.0065	–0.0477	0.7033	–0.130	0.2990	–0.166	0.183
FEV_3	0.3628*	0.0028	–0.0053	0.9662	–0.195	0.4460	–0.111	0.374
$FEF_{25–75\%}$	0.2209	0.0746	–0.0665	0.5950	–0.054	0.6680	–0.315*	0.010
$FEF_{0.2–1.2}$	0.2020	0.1038	0.0330	0.7920	–0.002	0.9850	–0.165	0.1860
PEFR	0.2401	0.0521	–0.0313	0.8027	0.023	0.8550	–0.130	0.299
$FEF_{25\%}$	0.1586	0.2033	–0.0620	0.6204	–0.034	0.7870	–0.221	0.0750
$FEF_{50\%}$	0.2450*	0.0474	–0.0871	0.4865	0.040	0.7520	–0.316*	0.0100
$FEF_{75\%}$	0.1838	0.1393	–0.1031	0.4099	–0.060	0.6310	–0.333*	0.0060
$FEV_{0.5}$/FVC%	–0.0272	0.8278	–0.1243	0.3220	–0.066	0.5970	–0.241	0.051
FEV_1/FVC%	–0.0274	0.8271	–0.2509*	0.0421	–0.136	0.2750	–0.275*	0.026
FEV_3/FVC%	0.0803	0.5212	–0.0868	0.4878	0.027	0.8310	–0.274*	0.026
MVV	0.1685	0.1762	–0.1286	0.3034	–0.213	0.0860	–0.111	0.373

Values represent "*r*" value of Pearson correlation coefficient, *$P < 0.05$ significant correlation, ***$P < 0.001$ highly significant correlation, FEV: Forced expiratory volume, BMI: Body mass index, BSA: Body surface area, FVC: Forced vital capacity, FEF: Forced expiratory flow, MVV: Maximum voluntary ventilation

workers. The chest X-ray and other radiological investigations can be taken into consideration for further studies.

CONCLUSION

The findings demonstrated that the poultry farm workers are more susceptible to altered pulmonary function test. Differences in respiratory pattern in poultry farm workers suggest that poultry dust has additional deteriorating effect on lung functions along with impact of age. The correlation between pulmonary function tests and anthropometric variables was also found to be statistically significant. Hence, lung functions need to be checked periodically to assess the impairment at an early stage.

REFERENCES

1. Lawniczek-Walczyk A, Górny RL, Golofit-Szymczak M, Niesler A, Wlazlo A. Occupational exposure to airborne microorganisms, endotoxins and β-glucans in poultry houses at different stages of the production cycle. Ann Agric Environ Med 2013;20:259-68.
2. Singh RA. The economics of poultry farming. In: Poultry Production. 3rd ed. Ludhiana: M/S Kalyani Publishers; 2011. p. 288-306.
3. Donham KJ, Cumro D, Reynolds S. Synergistic effects of dust and ammonia on the occupational health effects of poultry production workers. J Agromedicine 2002;8:57-76.
4. Gautam R, Heo Y, Lim G, Song E, Roque K, Lee J, *et al.* Altered immune responses in broiler chicken husbandry workers and their association with endotoxin exposure. Ind Health 2018;56:10-9.
5. Rylander R. Endotoxin in the environment – exposure and effects. J Endotoxin Res 2002;8:241-52.
6. Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A, *et al.* Standardisation of spirometry. Eur Respir J 2005;26:319-38.
7. Miller MR, Crapo R, Hankinson J, Brusasco V, Burgos F, Casaburi R, *et al.* General considerations for lung function testing. Eur Respir J 2005;26:153-61.
8. Wagner NL, Beckett WS, Steinberg R. Using spirometry results in occupational medicine and research: Common errors and good practice in statistical analysis and reporting. Indian J Occup Environ Med 2006;10:5-10.
9. Singh-Manoux A, Dugravot A, Kauffmann F, Elbaz A, Ankri J, Nabi H, *et al.* Association of lung function with physical, mental and cognitive function in early old age. Age (Dordr) 2011;33:385-92.
10. Sharma G, Goodwin J. Effect of aging on respiratory system physiology and immunology. Clin Interv Aging 2006;1:253-60.
11. Pellegrino R, Viegi G, Brusasco V, Crapo RO, Burgos F, Casaburi R, *et al.* Interpretative strategies for lung function tests. Eur Respir J 2005;26:948-68.
12. Dikshit MB, Raje S, Agrawal MJ. Lung functions with spirometry: An Indian perspective – I. Peak expiratory flow rates. Indian J Physiol Pharmacol 2005;49:8-18.
13. Dikshit MB, Raje S, Agrawal MJ. Lung functions with spirometry: An Indian perspective – II: On the vital capacity of Indians. Indian J Physiol Pharmacol 2005;49:257-70.
14. Velkumary S, Chandrasekaran K, Krishnamurthy N, Saranya K, Dhanalakshmi Y. Correlations of diaphragm thickness and body surface area on pulmonary functions in healthy adults. Int J Physiol 2013;1:153-5.
15. Barrett KE, Barman S, Boitano SM, Brooks HL. Introduction to pulmonary structure and mechanics. In: Ganong's Review of Medical Physiology. 25th ed. New Delhi: Tata McGraw-Hill Education Publication; 2016. p. 621-38.
16. Pal GK, Pal P, Nanda N. Pulmonary function tests. In: Comprehensive textbook of Medical Physiology. 1st ed. New Delhi: Jaypee Brothers Medical Publishers; 2017. p. 965-72.
17. Cotes JE, Chinn DJ, Miller MR. Lung function. In: Physiology, Measurement and Application in Medicine. 6th ed. UK: Blackwell Scientific Publications; 2006. p. 122-3.
18. Ravi K. Structure-function relationships of the lung; Ventilation. In: Tandon OP, Tripathi Y, editors. Best and Taylors Physiological Basis of Medical Practice. 13th ed. Gurgaon: Wolters Kluwer Health (India); 2012. p. 581-91.
19. National Health and Nutrition Examination Survey (NHANES). Anthropometry Procedures Manual; 2007. Available from: http://www.cdc.gov/nchs/data/nhanes. [Last accessed on 2016 Jul 17].
20. Du Bois D, Du Bois EF. A formula to estimate the approximate surface area if height and weight be known 1916. Nutrition 1989;5:303-11.
21. Garrow JS, Webster J. Quetelet's index (W/H2) as a measure of fatness. Int J Obes 1985;9:147-53.
22. Wunschel J, Poole JA. Occupational agriculture organic dust exposure and its relationship to asthma and airway inflammation in adults. J Asthma 2016;53:471-7.
23. Viegas S, Faisca VM, Dias H, Clerigo A, Carolino E, Veigas C. Occupational exposure to poultry dust and effects on the respiratory system in workers. J Toxicol Environ Health A 2013;76:230-9.
24. Whyte RT. Aerial pollutants and the health of poultry farmers. Worlds Poult Sci J 1993;49:139-56.
25. Senthilselvan A, Dosman JA, Kirychuk SP, Barber EM, Rhodes CS, Zhang Y, *et al.* Accelerated lung function decline in swine confinement workers. Chest 1997;111:1733-41.
26. Oyarzun GM. Pulmonary function in aging. Rev Med Chil 2009;137:411-8.
27. Janssens JP. Aging of the respiratory system: Impact on pulmonary function tests and adaptation to exertion. Clin Chest Med 2005;26:469-84, 6-7.
28. Bhardwaj P, Poonam K, Jha K, Bano M. Effects of age and body mass index on peak-expiratory flow rate in Indian population. Indian J Physiol Pharmacol 2014;58:166-9.
29. Kirychuk SP, Senthilselvan A, Dosman JA, Juorio V, Feddes JJ, Willson P, *et al.* Respiratory symptoms and lung function in poultry confinement workers in Western Canada. Can Respir J 2003;10:375-80.
30. Vidja K, Bhabhor M, Paramar D, Kathrotia R, Dodhia S, Mehta N. A comparative study of pulmonary functions in different age groups. NJIRM 2013;4:149-55.
31. Puthi N, Multani NK. Influence of age on lung function tests. JESP 2012;8:1-6.

How to cite this article: Taluja MK, Gupta V, Sharma G, Arora JS. A comparative study of pulmonary function tests in different age groups of healthy people and poultry farm workers in Ludhiana city. Natl J Physiol Pharm Pharmacol 2018;8(12):1609-1616.

Source of Support: Nil, **Conflict of Interest:** None declared.