Original Research Article

Status of lung functions in buffing polishing workers and the impact of yogic regimen on their pulmonary health

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Abstract

Background: The metal buffers & polishers in automobile industry are exposed to inhalation of air borne metal dust. Deposition of this metal dust in respiratory tract, in due course of time, can cause obstructive, restrictive or combined respiratory disease. **Aims and Objectives:** Yoga and pranayama may play an impressive role in improving the pulmonary functions and facilitating gas diffusion at the alveolo-capillary membrane. This study was aimed to record the pulmonary function tests (PFTs) in buffing polishing workers of an automobile industry before and after 12 weeks of yoga regimen. **Materials and Methods:** 35 male subjects of the age group of 25-40 years working on buffing polishing machine for 4-6 hours/day, 6 days in a week for more than 2 years were selected as subjects from an automobile industry. PFTs were carried out on all the subjects at the onset of the study and after12 weeks of subjecting them to a standardized yogic regimen. PFT parameters were analysed between group and with controls by ANOVA followed by Tukey's Test. **Results:** Significant improvement was seen in slow vital capacity, forced vital capacity, peak expiratory flow rate, maximum voluntary ventilation, and DLCO after following yogic regimen. FEV1, and FEV1% also showed a trend towards improvement in buffing polishing workers. **Conclusions:** Yoga and pranayama breathing exercises can improve the lung functions of the industrial workers. These can be encouraged as a part of their routine schedule as it can reduce absenteeism by improving their health.

Keywords: Buffing polishing workers, automobile industry, pulmonary functions, yoga, pranayama.

Introduction

Occupational diseases comprise of a group of illnesses that are caused by either repeated, extended exposure or a single, severe exposure to irritating or toxic substances that leads to various systemic manifestations. Metal buffer polishers clean, brighten, and restore solid or plated items made of iron, cobalt, copper, aluminium and alloys in automobile industry and are mainly exposed to iron dust.

There is enough literature demonstrating the hazardous pulmonary effects of metal particles if they are present in excess of the recommended levels in the workplaces. The main occupational respiratory hazard associated with hard metal industry is due to the effect of excessive inhalation of air borne metal dust[1]. Deposition of metals in respiratory passages and lungs in due course of time can cause obstructive, restrictive or combined lung disease. Asthma, fibrosing alveolitis, interstitial pulmonary fibrosis, pneumonitis and even lung cancer can occur as a consequence of acute or chronic exposure[2,3]. It has also been mentioned that chronic exposure is more hazardous than acute exposure[2,4].

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Almost all the parameters of pulmonary function test (PFT) including diffusion factor of lung for carbon monoxide (DLCO) have been found to be reduced in different industrial workers[5,9]. DLCO is a very important indicator for the diagnosis and monitoring the progress of almost all the parenchymal diseases of the lungs but very few studies are available where DLCO has been recorded in industrial workers[10]. Moreover we didn't find any study where PFTs along with DLCO have been measured in buffing polishing workers.

Yoga is a wholesome science and an art-related discipline, which not only deals with physical exercises but also has a spiritual and mental dimensions, it can be extensively used in all climatic conditions to bring about an ideal positive mental makeup. Yoga is not a system of medicine; it is a way of life, the implications of which go beyond health and disease[11]. Preventive and curative benefits of yoga and pranayama have been observed by many researchers. Slow and deep breathing reduces dead space ventilation and refreshes the air throughout lungsand thereby causing a generalized decrease in the excitatory pathways regulating respiratory systems[10,11]. Pranayama has also been found to cause maximal lung inflation which in turn stimulates pulmonary stretch receptors. This stretch receptor reflex decreases the tracheobronchial smooth muscle tone, which in turn decrease air resistance and increase airway calibre thereby improving the lung functions[12,13]. So Yogic regimen may play a vital role in changing the milieu at the bronchioles, particularly at the alveolar-capillary membrane to facilitatediffusion and transport of gases.Plenty of literature is available on the benefits of yoga in normal subjects as well as in various systemic disease conditions but effects of yoga in industrial workers specially in buffing polishing workers have not been studied much. The Harvard Business School study, drawn over a period of 11 years, showed a marked relationship between the strength of the organization's corporate culture and its profitability[14]. Such a change in the psycho-motivation of people was found to be useful at the organizational level as it reduced the absenteeism rate by improving their mental and physical health[15,16].Data is lacking about the pulmonary health of buffing polishing workers. Inclusion of Yoga and Pranayama in their routine life can help in improving their pulmonary heath as it has shown promising results in various other conditions. So to measure the lung functions in buffing polishing workers in an automobile industry and to see the impact of yogic lifestyle interventionon their lung functions, we planned this study.

Material and methods

Selection of subjects

A total of 42 people were approached in a buffing polishing unit of automobile industry of Mayapuri industrial area and 35 agreed to be a part of this study. Thus, a total of 35 male subjects of age group 25-40 years (mean 31.08 ± 2.59) were included in the present study (Group-1). Only those subjects who were working in that industry for the last 2 years or more and exposed to buffing polishing machine for 4-6 hours/day, 6 days in a week were included in the present study. Same number of age and sex matched healthy subjects who were not involved in buffing polishing work, belonging to the same socioeconomic status were also selected as controls (Group-II). Any person suffering from acute or chronic infections like tuberculosis, chronic obstructive pulmonary disease, hypertension, diabetes mellitus or having a history of smoking or alcoholism were excluded from the study.Reason for the sample size: 31 subjects per group were required for 80% power and 5% level of significance to detect a difference in change (before-after) yoga by 0.3 in FEV1, assuming no mean change in control group and taking standard deviation of 0.5 in both the groups[17].Adding 10% loss to follow up we had taken 35 subjects per group. Thankfully all our subjects willingly did yogic exercises and we were able to measure PFTs in all our subjects.

Study design

This was a prospective observational study where the effect of yoga was observed on PFTs of buffing polishing workers. PFT recordings were done in the pulmonary function lab of the Department of Physiology, University College of Medical Sciences, Delhi. The ethical clearance was obtained from the Ethical Committee of the institution before starting the study and written consent from each subject was taken before recruiting them in the study. All the subjects underwent complete physical and clinical assessment. Heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean blood pressure (MBP) were also recorded in both the groups.

Blinding and masking

As this was an interventional study double blinding was not possible. Here, the statistician and data analyst was blinded to the intervention status of the patients.

Intervention for the study group

Buffing polishing workers belonging to the test group performed yogic exercises for 45 min daily 6 days in a week for 12 weeks under the supervision and guidance of a yoga instructor trained from CCRYN, New Delhi. The yogic regimen which was followed included breathing exercises (pranayama), asanas and relaxation techniques (details are given in Table-1). A room was arranged at the industry setup itself where these subjects underwent yogic practices so that they don't have to travel to some other place or they miss out their wages. Dropout rate was also taken care of by this way and no subject in test group missed his yoga session.

Yoga regimen followed by the Test Group subjects

Asanas, deep breathing techniques and relaxation techniques: 45 min

Pranayama: 20 minutes

1. Bhastrika: 2 min
2. Kapalbhati : 8 min
3. Anulom-Vilom: 10 min

Asanas: 20 minutes

1. Tadasana- 2 times
2. Trikonasana- 2 times
3. Mandukasana- 3 times
4. Pavanmuktanasana- 3 times
5. Bhujangasana- 3 times

Ralaxation in Shavasana: 5 minutes

Intervention for the control group

Subjects in the control group continued with their daily routine activities as they did not undergo any yoga intervention.

Test procedure: Recording of all the parameters of PFTs in both the groups were done twice during the study period: First on 0 day as basal recording and then recordings were repeated after 12 weeks of following yogic intervention. Parameters of PFT recorded were: Slow vital capacity (SVC), forced vital capacity (FVC), forced expiratory volume in 1st sec (FEV1), FEV1/FVC ratio, peak expiratory flow rate (PEFR), maximum voluntary ventilation (MVV), and single breath DLCO. These lung functions were assessed by using computerized MS Medisoft Cardio-respiratory Instrument, HYP'AIR Compact model of cardio-respiratory testing machine manufactured by P K Morgan, India. The data was analyzed and the results were shown on the computer screen. A total of three tests were performed for all the lung functions and the best of the three fulfilling the criteria of reproducibility and vitality was considered for analysis.

Statistical analysis

The data was analyzed intergroup as well as intragroup by using SPSS (Statistical Package for the Social Sciences) version-20. The baseline values of the two groups were checked for normal distribution by nonparametric Kolmogorov-Smirnov Test. PFTs and DLCO within the groups before and after 12 weeks of yoga were compared by using repeated measures ANOVA followed by Tukey's test. Significance was considered at P< 0.05. For comparison of PFTs and diffusion capacity between the two groups, unpaired Student's T-test was applied.

Results

In the present study the intergroup comparison of PFT parameters depicted that almost all the parameters of PFTs (SVC, FVC, FEV1, PEFR and MVV) of Test group subjects were significantly lower than that of control group at the onset of study. Diffusion capacity (DLCO) was also low in the test group but it was statistically non significant. (Table-2)Intragroup comparison of PFT parameters in group-1 after 12 weeks of following yoga intervention showed significant improvement in all the parameters of PFTs including DLCO. It was also found that after 12 weeks of following yogic regimen the SVC, FVC, PEFR and DLCO values were even better in our subjects than that of the control group although it was statistically non-significant (Table-3). The changes in pre and post values of PFTs in control group were found to be non-significant.

Table 1: Intergroup comparison of PFTs before and after intervention

Pulmonary function tests	Baseline Recording		P -value	After 12 weeks (Post intervention)		P-value
	Subjects (mean±SD)	Controls (mean±SD)		Subjects (mean±SD	Controls (mean±SD)	
SVC (L)	3.53±0.190	3.81±0.370	.026	3.81±0.168	3.75±0.191	.167
FVC(L)	3.35±0.171	3.75±0.377	.024	3.79±0.215	3.73±0.320	.360
FEV1(L)	2.27±0.354	2.92±0.251	<.001	2.93±0.488	2.94±0.224	.970
FEV1%(%)	69.54±2.41	77.44±2.56	<.001	78.25±2.97	78.28±1.98	1.0
PEFR(L/sec)	6.72±0.50	7.52±0.610	.003	7.53±0.491	7.47±0.502	.812
MVV(L/min)	63.48±7.746	75.04±6.051	.035	69.97±5.674	74.37±4.070	.654
DLCO(ml/min/mmHg)	23.93±1.841	25.44±1.718	.319	27.05±1.962	25.04±1.345	.854

SVC = Slow Vital capacity; FVC = Forced vital capacity; FEV1 = Forced expiratory volume in 1sec; PEFR = Peak expiratory flow rate; MVV = Maximum voluntary ventilation; DLCO = Diffusion factor of the lung for carbon monoxide

Table 2: Intragroup comparison of PFTs before and after yogic intervention

Pulmonary function tests	Subjects		P value	Controls		P-value
	Baseline recording (mean±SD)	After 12 weeks of yogic regimen (mean±SD)		Baseline recording (mean±SD	After 12 weeks (mean±SD)	
SVC (L)	3.53±0.190	3.81±0.168	.017	3.81±0.370	3.75±0.191	.396
FVC(L)	3.35±0.171	3.79±0.215	.015	3.75±0.377	3.73±0.320	.811
FEV1(L)	2.27±0.354	2.93±0.488	<.001	2.92±0.251	2.94±0.224	1.0
FEV1% (%)	69.54±2.41	78.25±2.97	.010	77.44±2.56	78.28±1.98	1.0
PEFR(L/sec)	6.72±0.500	7.53±0.491	<.001	7.52±0.610	7.47±0.502	.709
MVV(L/min)	63.48±7.746	69.97±5.674	<.001	75.04±6.051	74.37±4.070	.588
DLCO(ml/min/mmHg)	23.93±1.841	27.05±1.962	.016	25.44±1.718	25.04±1.345	.281

SVC =Slow Vital capacity; FVC = Forced vital capacity; FEV1 = Forced expiratory volume in 1sec; PEFR = Peak expiratory flow rate; MVV = Maximum voluntary ventilation; DLCO = Diffusion factor of the lung for carbon monoxide

Discussion

In the present study the baseline values of all the parameters of the PFTs, i.e. Forced Vital Capacity (FVC), Vital Capacity (VC), Forced expiratory volume in 1 sec (FEV1), FEV1%, Peak Expiratory Flow Rate (PEFR) and Maximum Voluntary Ventilation (MVV) were found to be significantly low in buffing polishing workers of automobile industry as compared to the Control group. Lung Diffusion (DLCO) was also found to be low in buffing polishing workers although the result was not statistically significant. These results suggest that the pulmonary functions deteriorate in industrial workers as they are exposed to the metal dust. A combined restrictive and obstructive type of pattern was seen in these workers in our study. PFTs have been carried out by various researchers in various automobile industrial workers but in buffing polishing workers, the lung function data is lacking.Moreover in most of the studies three or four parameters of pulmonary function testing were measured in industrial workers[4,5,9]. Most of the studies have not recorded all the parameters of PFTs in industrial workers and diffusion capacity (DLCO) which can diagnose almost all the lung parenchymal diseases have not been recorded by most of them. Our study tried to fill this lacuna by involving all the possible parameters to investigate the extent of derangement of pulmonary functions.

Our findings are in comparable to several other researchers who have found impaired pulmonary functions following metal dust inhalation and concluded significantly reduced ventilatory functions (FVC, SVC, FEV1and DLCO) in hard metal shapers. Kezunović LC et al examined the prevalence of chronic respiratory symptoms by studying the spirometric parameters in aluminium pot room workers. Although the prevalence of chronic respiratory symptoms were reported by the pot room workers was quite high at the group level, they were not associated with ventilatory impairments[18]. Chattopadhyay BP et al. studied pulmonary functions in aluminium smelter plant along with workers working at the captive power plant and compared it with surrounding community people. They observed that in smelter plant workers both the restrictive and obstructive impairments were higher as compared to captive power plant workers and the community people[19]. Some of the researchers evaluated associations between dust exposure and lung function in steelworkers[4,20,21]. Dust exposure was observed as a deteriorating factor for FEV1, FVC, and FEV1/FVC%.In the present study, we found that in the study group the values of FVC, SVC, FEV1, FEV1% PEFR, MVV and DLCO showed a statistically significant improvement after 12 weeks of following yoga regimen. To the best of our knowledge this could be the first study to see the effect of yogic intervention in buffers and polishers of automobile industry. There are many studies which investigated the effect of Pranayama breathing on pulmonary functions in healthy individuals as well as in diseased population[22-26]. Pranayama was found to inflate the lungs and to stimulate the pulmonary stretch receptors which may decrease the tracheobronchial smooth muscle tone. This in turn decreases the air resistance and increases the calibre of the airways, which may help lung functions to improve.Yoga and Pranayama increases oxygen uptake up to 5 times thus causing a substantial increase in tissue oxygenation [12,13]. Moreover, endurance power and diffusion capacity of the lungs also improves after practicing yoga.in healthy as well as in diseased conditions[28]. Dinesh T et al. found that yoga training for 12 weeks improves lung function, strength of inspiratory and expiratory muscles as well as skeletal muscle strength and endurance [29]. Rachiwong S *et al*. studied the effects of modified Hatha yoga in industrial rehabilitation on physical fitness and stress of injured workers and found that there is significant improvement in yoga group in terms of flexibility, hand grip strength, and vital capacity[28-29].There is scanty literature regarding the effect of yogic exercises on pulmonary functions of automobile industry workers. So, we planned our study in this new dimension and found that yogic exercises replicate their beneficial effects in industrial workers as well. Yoga not only improves all the parameters of pulmonary function tests but also the ventilatory functions of the lung and can improve the parenchymal diseases or changes at the earliest. So Yoga can be included in the daily routine of buffers and polishers along with the other preventive measures to improve their lung functions and to protect them from various respiratory diseases.

Strengths of the study

To the best of our knowledge this could be the first study to see the effect of yogic intervention on in buffers and polishers of automobile industry on their PFTs. As all the parameters of PFTs have not been recorded in industrial workers in previous studies, our study tried to fill this lacuna by involving all the possible parameters to investigate the extent of derangement of pulmonary functions in buffing polishing workers.

Limitations

The study was unable to correlate metal dust concentration in air to the extent of derangement in parameters assessed. The study design did not include metal concentration in blood/urine so no correlation could be drawn between body concentration and deranged parameters. The study included a small sample size and better results would have been obtained with a larger sample size. In our study, the assessment was done only twice. Had the study been of longer duration, multiple time assessments would have been possible.

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