

CORRELATION OF PULMONARY PARAMETERS AND QUALITY OF LIFE AMONG OCCUPATIONALLY EXPOSED TO SILICA WORKERS: A RANDOMIZED CLINICAL TRIAL

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Abstract

Back ground of the study: Silicosis is an old occupational disease; it is common major and the most serious of all the pneumoconiosis. The workers who are exposed to silica are affected with silicosis and other pulmonary disorders. Crystalline Silica is a common mineral found in materials such as sand, quartz, concrete, masonry and rock, by continuous exposure to dust containing free silica. The aim of the study to determine the effectiveness of pulmonary rehabilitation on pulmonary parameters and quality of life among workers who are occupationally exposed silica. **Methods:-** A quantitative approach was used in this study. True experimental pretest and posttest research design was chosen for the study to assess the Effectiveness of pulmonary rehabilitation on pulmonary parameters and quality of life among workers occupationally exposed to silica. Duration of the study: One year (2022-May-2023-April). **Results:-** Effectiveness of pulmonary rehabilitation programme on quality of life physical health (7 items) of workers, occupationally exposed to silica. The median and percentiles of domain1 of WHO QOL BREF, the median score of control pre-test and post-test 3 were 20 and 21, respectively. The median score of experimental pre-test, post-test 1, post-test 2 and post-test 3 were 20, 21, 22 and 22, respectively. The correlation coefficient was found to be – 0.289. This shows that as the QOL increase the SGRQ decreases (P < 0.001). **Conclusion:-** The effectiveness of study was done with supervised breathing exercises(yoga), nutritional education. This improves the pulmonary parameters and efficacy of lung on occupational workers.

Keywords: Pulmonary Parameters, Quality Of Life, Pulmonary Rehabilitation, Occupational Workers.

INTRODUCTION

Silicosis, is being one of the oldest known occupational pulmonary hazards, free silica (SiO₂), or crystalline quartz, is still a major cause of disease. The major occupational exposures include mining, stone cutting, sand blasting, glass and cement manufacturing, foundry work, packing of silica floor, and quarrying, particularly granite. Most often, pulmonary fibrosis due to silica exposure (silicosis) occurs in a low dose - response fashion after many years of exposure.[1]

Silica is odorless, non-irritant and does not cause immediate effects. As silicosis is incurable, clinical management includes removing the workers from the industry and giving symptomatic treatment [2]. Prolong exposure to crystalline silica; inhalation dust turns into biologically active and deposited in the lungs, increase the risk of silicosis, chronic obstructive pulmonary diseases (COPD), and lung cancer. [3,4]

In 2017, the Global Burden of Disease (GBD) study identified 23,695 incident cases of silicosis (age-standardized incidence rate [ASIR] = 0.30 per 100,000), which represents 39% of the 60,055 incident cases of pneumoconiosis. [5] 'Silicosis' very name, coined in 1871, only reached medical consensus through the International Labour Organization (ILO) conference in Johannesburg (South Africa) in 1930, which led to an ILO convention in 1934. In 1958, an ILO agreement defined the chest radiograph features of the disease, and in 1995 an ILO/World Health Organization (WHO) Global Programme for the Elimination of Silicosis was established. The epidemiology of silicosis in Asia is described by the GBS Study. At a national level, the highest increase in average annual percentage change in ASIR was noted to be in Singapore, and globally the highest number of incident cases were in China (9066) and India (1464) [6]. India has a large mining industry, concentrated in the states of Chhattisgarh, Jharkhand, Orissa and West Bengal. In 1999, the Indian Council of Medical Research reported that around 3.0 million workers are at high risk of exposure to silica; of these, 1.7 million work in mining or quarrying activities, 0.6 million in the manufacture of non – metallic products (such as refractory products, structural clay, glass and mica) and 0.7 million in the metals industry.

The number of exposed workers is even higher in developing countries. [7] The large deposit of silica, clay and sand is found in Bethamcherla, Panyam, Cement Nagar, Malkapuram, Nandavaram villages. Quartzes near Orvakal and Kamarolu villages is high, it contains 99.62% of silica with less iron which is suitable in glass industry. There are about 650 Napa slab polishing units at Bethamcherla, Dhone and Kurnool district. The polished slabs of black, white, pink, light green types are being supplied to every nook and corner within the state and also outside. It is a good building stone used for flooring and roofing. Few more polishing units are start at Bethamcherla, based on the Napa slabs available in and around **Bethamcherla**. At present there are about 40 mosaic chip stone factories situated at **Bethamcherla**. The mining area contributes around 44.89sq.km; quarry area contributes around 92.25sq.km. total of 286.49sq.km. [8]

According to WHO 'most hazards conditions at work are in principle preventable and the primary prevention approach is the most cost - effective strategy for their elimination and control'. Prevention aims at interpreting the chain of exposure by means of elimination of source material, wet methods, safe work practices, isolation, local exhaust ventilation, education on personal protective equipment, monitoring of alarm system and health surveillance [9].

Proper breathing will help oxygenation of blood, removal of carbon dioxide thereby mental concentration, good health, and longevity. By doing Pranayama every day lung function will be strengthened. Alternate Nostril Breathing (Anulom Viloma Pranayama), It is the special type of breathing cycle involving alternate nostril, and gets commenced after expelling air forcefully from one nostril and taken from same nostril. Kapaladanda Pranayama helps to expand lungs; Bastrika Pranayama helps to exhale impurities in the lungs. It cures simple upper respiratory tract infections and oxygenates the blood properly. Its rate and rhythm can be varied easily by the person. It instantly gives a feeling of freshness and well-being.

It is advised to do at least for 10 -20 minutes every day for its benefit. Practicing of Pranayama will help to hold breath longer and increase strength to the respiratory muscles [10]. It will protect from many types of lung problems. Stimulates secretion of

pulmonary surfactant which increases exchange volume of lungs. Maintain level of prostaglandins which decreases bronchiolar smooth muscle tonicity leading to the enhanced flow of air into lungs [11]. Proper nutrition of the body is necessary for the development and growth of body and mind. Diet, physical activity, smoking is an impotent and interrelated for disease prevention and prognosis of respiratory infections. High intake of antioxidant and nutrients mostly fresh fruits and vegetables improves lung function and decline COPD symptoms.[12,13] Due to lack of literacy and less knowledge regarding the use of protective measures can produce a surplus effect. It is suggested that free seminars, symposiums, and medical camps are required at different levels at medical centers to increase the awareness about the cause and complications for silicosis among stone mine workers. [14] Pulmonary rehabilitation is a program of exercise, education and support, developed especially for people with occupational workers, shortness of breath, nutritional education to improve their health related quality of life.

Aim of the Study

To correlate the effectiveness of pulmonary rehabilitation on pulmonary parameters and quality of life among workers who are occupationally exposed silica.

Ethical Consideration

The Institute of Ethical Committee of Health Sciences under the Saveetha Institute of Medical and Technical Sciences approved a study (002/09/2022/IEC/SMCH) dated on 14/09/2022.

METHODS AND MATERIALS

A quantitative approach was used in this study. Quasi experimental pretest and posttest research design was chosen for the study to correlate the Effectiveness of pulmonary rehabilitation on pulmonary parameters and quality of life among workers occupationally exposed to silica. Duration of the study: One year (2022-May-2023-April). Workers with silica dust exposed in Bethamcherla factory was control group and whereas Cement Nagar was experimental group who meet the inclusion criteria were considered sample for the study was taken.

Data Collection Procedure

Investigator was initially checked temperature, pulse rate, respiratory rate, blood pressure, saturation (SPO₂). Explained the procedure to the workers who were exposed to silica by a detailed description about the Spirometer, 6MWT, Breathing exercises and nutritional education, including a reference pamphlet after assessing St. George's Respiratory Questionnaire, (SF-36, SGRQ) and WHO QOL-BREF questionnaire. Data were collected by face to face interview from the occupational workers. Then the investigator make sample to do spirometry followed by administer 6MWT (exercise tolerance test), breathing exercises (pranayama) which help the sample to increase lung function. Spirometry for 5 minutes and 6 minutes for walk test and breathing exercises for 15-20 minutes at the interval of 30 minutes. All these interventions were carried out for 4 days a week for continuation of three months. For the control group, routine care was given followed with same tools. For an experimental group initially checked vitals temperature, pulse, respiration and systolic and diastolic blood pressure were recorded. After that weight with weighing scale and height with chart used to calculate BMI and recorded, and modified mini- nutritional

scale used to assess nutritional status. After explanation about collection of blood sample, the investigator has collected and transported to laboratory tests HB%, ESR and RBS. Later results were collected and recorded. Chest X-Ray was done both control and experimental group. Post test was conducted after three months and six months and later one year. The questionnaires were demographic, clinical parameters, WHO QOL-BREF questionnaires. George's Respiratory Questionnaire, and modified mini nutritional scales were used to collect the data for both experimental and control group.

DATA ANALYSIS

The data was analyzed by descriptive and inferential statistical methods using SPSS statistical package (Systat software Inc. San Jose, USA). The demographic and clinical variables were described as frequency and percentage. The effectiveness of intervention within the group was calculated by paired t test, and the effect of intervention between the experimental and control group was compared by unpaired t test. Inferential statistics like t test, Chi square test, ANOVA and repeated measures ANOVA and other relevant statistical techniques.

RESULTS AND DISCUSSION

In this study to correlate the effectiveness of Pulmonary Rehabilitation programme on quality of life among silica exposed occupational workers Physical Health (7 items) of Median and Percentiles was given in figure1. The median score of control pre-test and post-test 3 were 20 and 21, respectively. The median score of experimental pre-test, post-test 1, post-test 2 and post-test 3 were 20, 21, 22 and 22, respectively. Kruskal Wallis one-way ANOVA on ranks showed statistical significance ($P < 0.001$). Within group comparison of control pre-test and post-test 3, did not show significance ($P = 0.358$). The experimental group showed progressive improvement in the median score. Within group comparison of experimental pre-test and post-test 3, showed significance ($P = 0.002$). Between group comparison of control and experimental pre-test, did not show significance ($P = 1.0$). Between group comparison of control and experimental post-test 3, showed significance ($P = 0.037$).

Figure: 1 The Median and Percentiles of domain1 (Physical Health) of WHO QOL- BREF in Control and Experimental group.

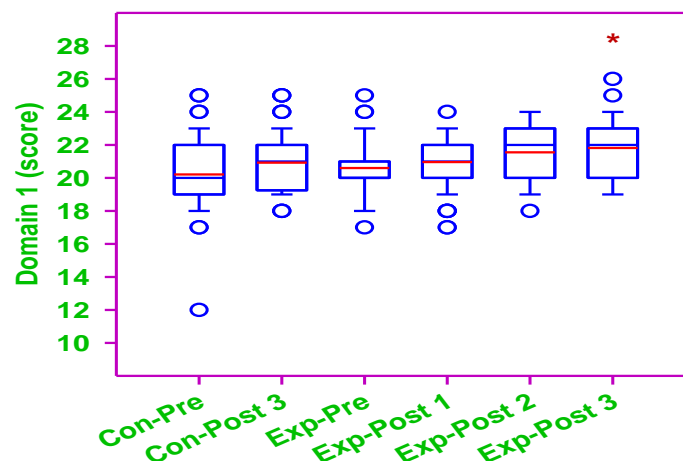


Table 1: Comparison of WHO -QOL among in Control and Experimental groups.

S.No.	Group comparisons	Test	Median	Percentiles	Statistics
1	Control	Pre-test	74.00	70.00-79.00	H = 116.24 P < 0.001
	Control	Post-test 3	77.00	73.25-83.00	
	Experimental	Pre-test	74.00	72.00-77.00	
	Experimental	Post-test 1	77.00	75.00-79.00	
	Experimental	Post-test 2	79.00	76.00-84.00	
	Experimental	Post-test 3	84.00	77.00-86.75	
2	Within group comparison (Control - Pre-test/Post-test 3)				Q =3.789 P =0.002
	Within group comparison (Experimental - Pre-test/Post-test 1)				Q = 2.309 P = 0.314
	Within group comparison (Experimental - Pre-test/Post-test 2)				Q = 5.329 P <0.001
	Within group comparison (Experimental - Pre-test/Post-test 3)				Q = 8.640 P <0.001
	Within group comparison (Experimental - Post-test 1/Post-test 2)				Q =3.018 P = 0.038
	Within group comparison (Experimental - Post-test 1/Post-test 3)				Q = 1.064 P =1.000
	Within group comparison (Experimental - Post-test 2/Post-test 3)				Q = 3.325 P = 0.013
3	Between group comparison (Control/Experimental - Pre-test)				Q = 8.763 P = 0.405
	Between group comparison (Control/Experimental - Post-test 3)				Q = 9.040 P <0.001
n –	Control = 80 in Pre-test and Post-test 3 Experimental = 80 in Pre-test, 79 in Post-test 1, 78 in Post-test 2 and 77 in Post-test 3.				
The 'H', 'Q' and 'P' values are by Kruskal Wallis one-way ANOVA on ranks with Dunn's multiple comparisons test.					

The Median and Percentiles of total score of WHO QOL BREF was given in Table 1. The median score of control pre-test and post-test 3 were 74 and 77 respectively. The median score of experimental pre-test, post-test 1, post-test 2 and post-test 3 were 74,77,79 and 84 respectively. Kruskal Wallis one-way ANOVA on ranks showed statistical significance (P < 0.001). Within group comparison of control pre-test and post-test 3, did not show significance (P=0.002). The experimental group showed progressive improvement in the median score. Within group comparison of experimental pre-test and post-test 3, showed significance (P <0.001). Between group comparison of control and experimental pre-test, did not show significance (P = 1.0). Between group comparison of control and experimental post-test 3, showed significance (P <0.001).

Table: 2 Correlation of QOL and SGRQ among control and experimental group.

WHO QOL BREF	SGRQ	r = - 0.289	P < 0.001
For the correlation, the post-test 3 of control and experimental groups were combined. r = Correlation coefficient P = Probability n = 160			

The correlation coefficient and probability of WHO QOL BREF and SGRQ are given in Table 2. The correlation coefficient was found to be – 0.289. This shows that as

the QOL increase the SGRQ decreases ($P < 0.001$). Since the correlation coefficient was not more than 0.5, they could be considered as important.

Table 3: Comparative analysis of Baseline Clinical Parameters of Control and Experimental groups.

S.No.	Variable	Analysis	Con	Exp	Statistics
1	Age (years)	Mean	42.7	41.9	t = 0.438
		SEM	1.3	1.3	P = 0.662
2	Weight (kg)	Mean	55.2	56.8	t = 1.862
		SEM	0.6	0.6	P = 0.0645
3	Body mass index (kg/m ²)	Mean	22.42	22.86	t = 1.233
		SEM	0.24	0.27	P = 0.219
4	Pulse rate (beats/min)	Mean	85.1	89.2	t = 2.139
		SEM	1.2	1.5	P = 0.0340
5	Respiratory rate (breath/min)	Mean	19.7	19.7	t = 0
		SEM	0.1	0.1	P = 1.0
6	SpO ₂ (%)	Mean	97.1	97.8	t = 2.412
		SEM	0.2	0.2	P = 0.0170
7	Systolic blood pressure (mmHg)	Mean	123.0	124.5	t = 0.720
		SEM	1.4	1.6	P = 0.473
8	Diastolic blood pressure (mmHg)	Mean	78.0	77.6	t = 0.387
		SEM	0.7	0.7	P = 0.699
9	Haemoglobin (g/dL)	Mean	10.1	10.8	t = 3.220
		SEM	0.2	0.1	P = 0.0016
10	Erythrocyte sedimentation rate (mm/hr.)	Mean	15.4	15.9	t = 1.295
		SEM	0.3	0.2	P = 0.197
11	Random blood sugar (mg/dL)	Mean	141.1	148.8	t = 0.739
		SEM	6.5	8.2	P = 0.461
n – Control = 80; Experimental = 80. SEM = Standard error of mean. The 't' and 'P' values are by Student's 't' test.					

The mean and SEM of control and experimental groups clinical variables are given in Table 3. The mean age of control and experimental groups were 42.7 and 41.9 (years), respectively. It was not found to be significant ($P = 0.662$).

The mean weight of control and experimental groups were 55.2 and 56.8 (kgs), respectively. It was not found to be significant ($P = 0.0645$).

The mean Body mass index of control and experimental groups were 22.42 and 22.86 ((kg/m²), respectively. It was not found to be significant ($P = 0.219$). The mean Pulse rate of control and experimental groups were 85.1 and 89.2 (beats/min), respectively. It was not found to be significant ($P = 0.0340$). The mean Hemoglobin of control and experimental groups were 10.1 and 10.8 (g/dL), respectively. It was found to be significant ($P = 0.0016$).

The mean Erythrocyte sedimentation rate of control and experimental groups were 15.4 and 15.9 (mm/hr) respectively. It was found to be significant ($P = 0.197$).

Table 4: Influence of gender, age, education, occupation on Treatment outcome by Three- Way ANOVA.

S.No.	Statistical analysis 3-way ANOVA	WHO QOL BREF	SGQR
1	Gender (male/female)	F = 8.466 P = 0.004	F = 0.924 P = 0.337
2	Groups (control/experimental)	F = 10.733 P < 0.001	F = 9.569 P = 0.002
3	Tests (pre-test/post-test 3)	F = 56.525 P < 0.001	F = 0.0744 P = 0.785
4	Gender X Group	F = 3.243 P = 0.073	F = 0.561 P = 0.455
5	Gender X Test	F = 0.726 P = 0.395	F = 0.0116 P = 0.914
6	Group X Test	F = 6.322 P = 0.012	F = 7.587 P = 0.006
7	Gender X Group X Test	F = 5.604 P = 0.019	F = 0.577 P = 0.448
n - Total participants = 160 (80 x 2 groups)			

The 3-way ANOVA results of gender on WHO QOL BREF and SGQR are given in Table 4. The gender category (male and female) in general showed statistical significance (P = 0.004). This is due to male in general showing higher QOL than female. The groups (Control and Experimental) and the tests (Pre-test/Post-test 3) showed significance as expected (P < 0.001 and < 0.001, respectively). The gender X group and gender X test did not show significance (P = 0.073 and 0.395, respectively). The group X test showed significance as expected (P = 0.012). Interestingly, the gender X group X test showed significance (P = 0.019). This is due to that the male benefited about 10 scores from the pre-test to the post-test 3, while the female benefited only about 5 scores from the pre-test to the post-test 3.

DISCUSSION

This randomized controlled study revealed that the pulmonary rehabilitation on occupationally exposed to silica workers the median score of control pre-test and post-test 3 were 20 and 21, respectively. The median score of experimental pre-test, post-test 1, post-test 2 and post-test 3 were 20, 21, 22 and 22, respectively. Physical activity (Domin- 1) showed progressive improvement with supervised pranayama (breathing exercises) and nutritional education, intervention was beneficial (David A 2017) [15] Simple pranayama like Kapala Bhathi, Anuloma Viloma and Bastric Pranayama were teaches to the occupational workers, which they can performed at home level which improves quality of life.[16] . Kruskal Wallis one-way ANOVA on ranks showed statistical significance (P < 0.001). An experimental group daily activity, their sleep, capacity of work was improved.

The median and percentiles of domain-2 (psychological health) of WHO QOL BREF, The experimental group showed progressive improvement in the median score. Within group comparison of experimental pre-test and post-test 3, showed significance (P < 0.001). Psychological aspects anxiety, mood, depression, concentration of work, and enjoyment activities was improved in experimental group. The median and percentiles of domain-3 (social relationships) of WHO QOL BREF, Kruskal Wallis one-way ANOVA on ranks showed statistical significance (P < 0.001). The experimental group showed progressive improvement in the median score. Within group comparison of experimental pre-test and post-test 3, showed significance (P < 0.001).

Between group comparison of control and experimental pre-test, did not show significance ($P = 1.0$). Between group comparison of control and experimental post-test 3, showed significance ($P = 0.030$). Experimental group personal, family relationships, support from family and friends were maintained. The median and percentiles of domain 4 (Environmental) of WHO QOL BREF, Kruskal Wallis one-way ANOVA on ranks showed statistical significance ($P < 0.001$). Occupational workers experimental group were satisfied in aspects like money to meet daily needs, health services, access to health services and transport facility. The median and percentiles of Total Score of WHO QOL BREF, The median score of control pre-test and post-test 3 were 74 and 77 respectively. The median score of experimental pre-test, post-test 1, post-test 2 and post-test 3 were 74, 77, 79 and 84 respectively. Kruskal Wallis one-way ANOVA on ranks showed statistical significance ($P < 0.001$). [17]

Various publications have reported clusters of silicosis cases caused by exposure to artificial stone dust. [18] In 2016, China reported 10 072 newly diagnosed patients with silicosis, among which 43.78% were concentrated in Sichuan, Hunan and Chongqing provinces and Beijing. [19] Within group comparison of control pre-test and post-test 3, did not show significance ($P = 0.002$). Between group comparison of control and experimental pre-test, did not show significance ($P = 1.0$). Between group comparison of control and experimental post-test 3, showed significance ($P < 0.001$).

The control and experimental groups demographic variables viz., gender, education, occupation and alcoholic liquid consumption the frequency distribution showed statistically significant ($P < 0.001$). The mean and SEM of control and experimental groups clinical variables, The mean age of control and experimental groups were 42.7 and 41.9 (years), respectively. It was not found to be significant ($P = 0.662$). The HB level of occupational workers showed statistically significant ($p = 0.0016$). Whereas BMI showed not to be statistically significant ($p = 0.219$). However, Obesity has been identified as a risk factor across all respiratory diseases. The occupational workers obesity was categorized according to ($BMI > 35 \text{ kg}\cdot\text{m}^{-2}$) obese and underweight ($BMI < 18.5 \text{ kg}\cdot\text{m}^{-2}$). Nutritional education will improve workers quality of life and minimizes the fibrotic lung diseases. [20] Similar study conducted by Wu N, Xue C (2020) [21] report revealed that, the severity of silicosis associated with artificial stone. More cases are likely to occur unless effective preventive measures are taken and safety practices are enforced. Occupational dust control is one of the key preventative measures against silicosis.

CONCLUSION

The present study findings concluded that pulmonary rehabilitation techniques, nutritional education and pranayama (breathing exercises) can improve quality of life, in terms of physical, psychological, social relationships and environmental aspects. The correlation coefficient was found to be -0.289 . This shows that as the QOL increase the SGRQ decreases ($P < 0.001$).

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Conflict Of Interest: - The authors declare there are no conflicts of interest.

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