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EFFECT OF ENVIRONMENTAL POLLUTION ON THE RESPIRATORY SYSTEM OF WORKERS IN THE INDUSTRIAL SECTOR

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Abstract

Despite dust being the primary hazard in cement processing and respiratory disorders being a significant occupational health concern in this sector, there has been inconclusive evidence regarding the link between exposure to cement dust and respiratory symptoms or functional decline. Therefore, this study was conducted to investigate the impact of occupational cement dust exposure on the respiratory system. The research involved 170 male workers currently exposed to cement dust and 130 healthy male office workers with no history of dust exposure, serving as a comparison group. Participants underwent interviews, completed respiratory symptom questionnaires, and underwent chest x-rays and lung function tests. Inhalable and respirable cement dust exposure levels were estimated at 54.6 ± 42.4 and 31 ± 11.3 mg/m3, respectively (Mean ± SD). Statistical analysis revealed significantly higher occurrence ($p<0.05$) of symptoms like regular cough, phlegm, wheezing, and shortness of breath among exposed workers. Chest X-rays of exposed workers showed varying degrees of abnormalities, including emphysematous changes, calcified granulomas, and evidence of inflammatory processes. However, the comparison group's x-rays displayed no notable changes. Furthermore, exposed workers demonstrated significant reductions in lung function parameters compared to the reference group. In conclusion, our findings provide additional supportive evidence to the notion that exposure to cement dust is associated with respiratory symptoms and functional impairments.

Keywords: Industrial environments , Pollution, atmospheric dust, smoking.

Introduction

Environmental pollution in the industrial sector can have significant negative effects on the respiratory system of workers. The respiratory system is particularly vulnerable to the harmful substances present in industrial pollutants [1]. Pollutants such as particulate matter (PM), volatile organic compounds (VOCs), sulfur dioxide (SO_2), and nitrogen oxides (NOx) can irritate the respiratory tract. Prolonged exposure can lead to inflammation of the airways, causing symptoms like coughing, wheezing, and shortness of breath. Workers with pre-existing respiratory conditions such as asthma, chronic obstructive pulmonary disease (COPD), or bronchitis are at higher risk [2]. Exposure to pollutants can exacerbate their symptoms and lead to more frequent and severe attacks. Long-term exposure to pollutants can lead to reduced lung function. The lungs may lose their elasticity, making it harder to breathe and decreasing the overall efficiency of oxygen exchange. Pollutants can weaken the immune system's response to respiratory infections, making workers more susceptible to illnesses such as pneumonia and bronchitis. Some industrial pollutants, such as asbestos, benzene, and certain metals, are carcinogenic and can increase the risk of lung cancer in exposed workers. Industries like mining and construction often produce fine dust containing silica particles [3]. Prolonged inhalation of silica dust can lead to silicosis, a lung disease that causes inflammation and scarring of the lung tissue. Workers exposed to specific substances like coal dust (leading to black lung disease) or cotton dust (causing byssinosis) are at risk of developing occupational lung diseases that primarily affect the respiratory system. Industrial environments may release allergens into the air, triggering allergic reactions in some workers, which can affect their respiratory health [4]. Noise pollution in industrial settings can lead to stress, which can indirectly affect the respiratory system through hormonal changes and increased susceptibility to respiratory infections. In some cases, workers might be required to wear personal protective equipment (PPE) such as masks or respirators to minimize exposure to pollutants. However, prolonged use of PPE can be uncomfortable and impact respiratory comfort and efficiency. Efforts to mitigate these effects should focus on both environmental and workplace safety measures. Implementing pollution control technologies, improving ventilation systems, and promoting regular health check-ups for workers can help reduce the impact of environmental pollution on their respiratory systems. It's crucial for industries to adhere to environmental regulations and prioritize worker safety to prevent or minimize these health risks [5].

Materials and Methods

Study Area and Respondent Detail

The present cross-sectional study was conducted at a cement industries located in Iraq. A cohort of 300 individuals who have a documented work history and are currently exposed to cement dust were identified as suitable participants for the research. The individuals were engaged in activities within three significant dusty regions, as elaborated upon in the segment pertaining to the quantification of airborne particulate matter. Following consultations with statisticians and epidemiologists, a

total of 170 individuals were chosen for the study using a stratified random sample technique, with the selection criteria being their current work categorization.
In a similar manner, a group of 130 male office employees who were in good health and had not been exposed to any specific factors were randomly chosen as the reference group. These individuals were picked from the same industry, ensuring that they had the same sex and ethnic background. Additionally, their level of education, salary, and family size were nearly equal to those of the other participants. Both groups consisted of participants who volunteered for the study. None of the subjects recruited for the research declined to participate. Prior to the initiation of the trial, all participants provided their signature on an informed consent document.
The study investigated the incidence of respiratory issues and alterations in lung function metrics within the aforementioned groups of individuals who were exposed and unexposed. None of the aforementioned participants had any prior medical or familial background of respiratory ailments or any previous thoracic surgeries or traumas. Likewise, it should be noted that none of the participants under consideration had been previously exposed to cement or any other chemical substances that are recognized to induce respiratory symptoms, ventilatory impairments, or anomalous radiographic alterations in the pulmonary system either during their tenure at the facility or before to it. Nevertheless, according to the initial interviews conducted by the researchers prior to the subjects' involvement in the study, and with reference to their medical examination records prior to employment, it was found that three of the randomly chosen individuals who had not been exposed to the study site had a medical history of tuberculosis (which had been fully treated before their employment), asthma, and allergic rhinitis (which they were currently experiencing). To mitigate the potential influence of confounding factors, the study excluded these three variables[7].

Measurements of smoking habit

The standardized questionnaire encompasses inquiries regarding respiratory symptoms such as the presence or absence of regular dry and/or productive cough, wheezing, and shortness of breath. It also covers nasal and eye symptoms, smoking habits, medical and family history of each participant, comprehensive occupational history, and specific queries pertaining to all previous occupations prior to employment at the plant under investigation, particularly those associated with the potential risk of respiratory morbidity [8].

Measurement of atmospheric dust:

In order to evaluate the level of employees' exposure to cement dust, a study was conducted to measure the concentration of airborne inhalable particles (with a particle size less than 5 µm) and respirable particles (with a particle size equal to or more than 5 µm) at several worksites with high levels of dust. The dusty worksites encompassed three primary domains: (1) the amalgamation and pulverization of raw materials, (2) the pulverization of a combination of clinker and gypsum, and (3) the screening and storage of cement within silos. To estimate the concentration of atmospheric dust particles, a personal dust sampler (Casella, London- LTD) was employed. The sampler was calibrated using a digital automatic calibrator, which was connected to a filter holder equipped with a 25 mm membrane filter with a pore size of 0.45 µm. Air was pumped through the filter by a battery-powered motor at a constant flow rate of 2 l/min. After conducting several initial experiments, it was determined that the optimal duration for sampling, in order to prevent filter overload, was found to be 120 minutes [9].

The dust concentration, denoted in milligrams per cubic meter (mg/m3), was determined by measuring the changes in weight of the dry filter (for the respirable fraction) or cyclone collector (for the inhalable fraction) using a digital scale with a sensitivity of 0.1 mg. These measurements were taken before and after sampling, and then divided by the volume of air that was sampled[10].

Lungs function tests

The study utilized pulmonary function tests (PFTs) to assess various parameters including mean percentage predicted Vital Capacity (VC), Forced Vital Capacity (FVC), Forced Expiratory Volume in the first second (FEV1), Peak Expiratory Flow (PEF), and Forced Expiratory Flow between 25% and 75% of the FVC (FEF25–75%). The spirometer underwent calibration twice daily using a 1-liter syringe, following the established technique for the specific instrument employed. If a particular individual exhibited significant variability across different forced vital capacity (FVC) levels, a total of eight maneuvers were recorded [11].

Chest radiography

Participants were recruited to a healthcare facility for the purpose of undergoing a medical evaluation conducted by a specialist in pneumology. As part of the examination, the participants experienced a Posterior-Anterior (PA) chest X-ray procedure, which was performed using a Seimens equipment. The interpretation of PA chest X-rays was conducted by a radiologist and a pneumologist. The dimensions of the film were measured to be 35 × 35cm, the distance between the person and the ×-ray tube was approximately six feet, and the electrical voltage applied was 100 kv [12].

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Determination of silica phases and SiO_2 content:

The dust samples were subjected to wet chemistry, X-ray diffraction (XRD), and X-ray fluorescence (XRF) methods in order to ascertain the silica phases present and quantify the SiO2 concentration [13].

Data analysis and statistical procedures

The data were subjected to statistical analysis using the Student's t-test. In cases where the standard deviations of two similar variables were substantially different according to the F test, Welch's alternative t-test was employed. Additionally, the Chi-square or Fisher exact test was used where appropriate, with a predetermined significance level of $p<0.05$. In instances when the anticipation of an impact resulting from an independent variable within a certain domain was uncertain, a statistical examination was performed utilizing a two-sided p-value. The experimental findings are reported in the form of arithmetic means accompanied by their corresponding standard deviations. Statistical analyses were performed using GraphPad InStat tm.

Results and Discussion

Table 1 and Figure 1 presents an overview of the physical attributes of the subjects, as well as their respective levels and durations of exposure to cement dust. Additionally, the table includes information on the SiO2 content of the dust samples and the length of smoking among the patients. The average age of the exposed people was somewhat higher compared to the unexposed participants. However, it is important to note that these differences, as well as the differences seen in other parameters, did not reach statistical significance.

Table 1. The physical characteristics, exposure data and length of smoking of study subjects (Mean ± SD)**

Parameter	Exposed (n=170)	Unexposed (n=130)	*p*-Value
Age (yr)*	39.2 ± 8.1	40.6 ± 7.4	0.05
Weight (kg)*	65.5 ± 9.6	75.3 ± 10.5	0.12
Height (cm)*	166.7± 6.1	169.4 ± 6.5	0.13
Years smoked*	6.1 ± 6.2	4.5 ± 6.8	0.76
Length of employment or exposure (yr)*	18.8 ± 7	15.8± 3.1	0.37
Inhalable dust concentration (mg/m3)	54.6 ± 42.4†	0 ± 0†	N/A
Respirable dust concentration (mg/m3)	31 ± 11.3†	0 ± 0†	N/A
Type of the crystalline silica phase	Quartz‡	NIL‡	
SiO_2 content	29.5%‡	0%‡	N/A

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*There was no statistically significant difference between the means of the two groups (Student's *t*-test, or Welch alternate *t*-test, where applicable, $p<0.05$). †=9, ‡=2, N/A: Not Applicable.

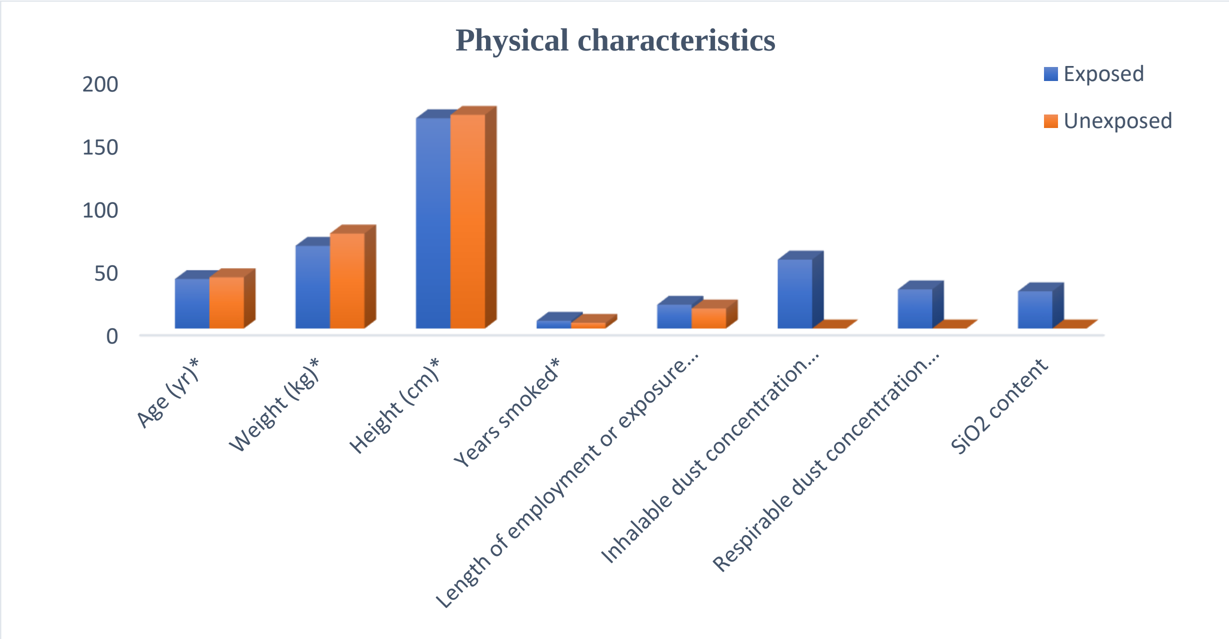

Figure 1: Shows the Physical characteristics of respondents

Table 2 and Figure 2 illustrates the distribution of individuals who smoke and those who do not smoke among both categories. The data indicates that there was not a statistically significant difference in the prevalence of smokers between the two groups.

Table 2. Distribution of study subjects by smoking habits

	Non smokers	Smokers	Total
Exposed	93	77	170
Unexposed	59	71	130
Total	152	148	300

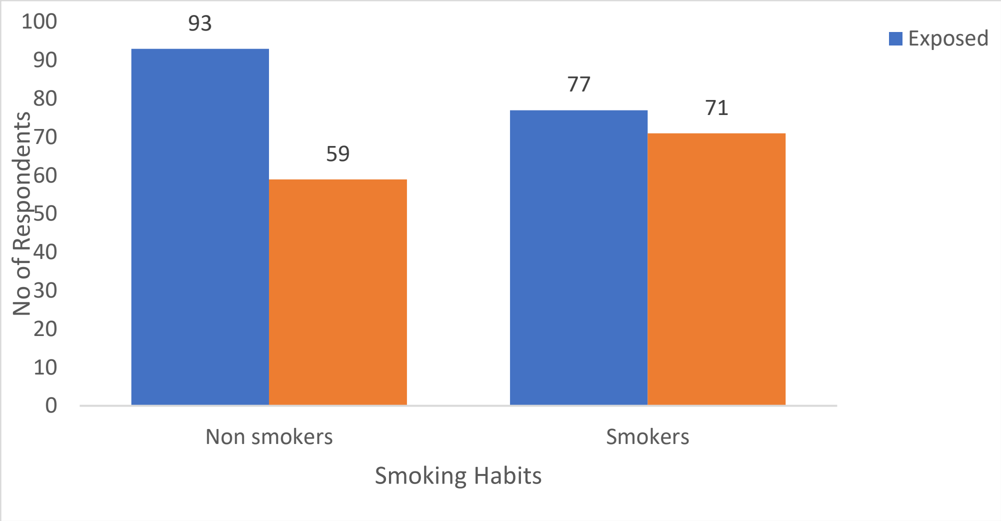

Figure 2: Shows the smoking habit of respondents

Table 3 and Figure 3 presents the incidence of atypical clinical observations among those who were exposed and those who were not exposed. Workers who were exposed to certain conditions, irrespective of their smoking status, had a greater prevalence of frequent cough, phlegm production, wheezing, and shortness of breath. The prevalence of these symptoms was higher among the individuals who smoked in both cohorts.

Table 3. Frequency (%) of abnormal clinical findings in exposed and unexposed subjects

Parameter	Exposed (n=170)	Unexposed (n=130)	*p*-Value
Wheezing	14% *	5%	<0.0001
Breathlessness	27% *	5%	0.006
Phlegm	31% *	15%	0.03
Cough	28% *	20%	0.04

*Significantly different (chi-square, $p<0.05$).

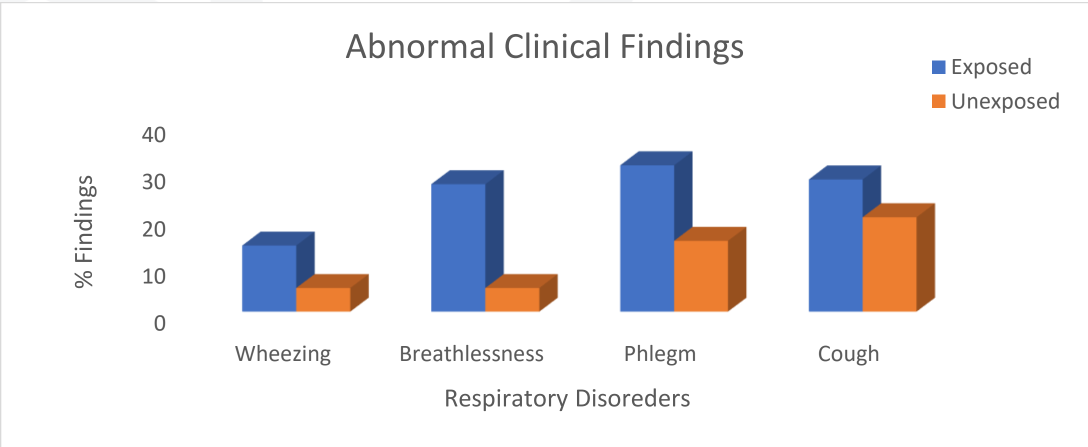

Figure 3: Shows the respiratory disorders of respondents

Table 4 presents the occurrence rate of atypical observations in chest radiographs among those who were exposed and those who were not exposed. As demonstrated, radiographs of personnel who were exposed to the substance exhibited a range of abnormalities, but the radiographs of individuals who were not exposed did not display any major alterations.

Table 4. Shows the findings of chest radiographs

Abnormality	Exposed (n=170)	Unexposed (n=130)	*p*-Value
Emphysematous changes	21%	0	<0.0001
Old calcified granulomas	12%	0	<0.01
Focusal calcification of the lungs	28%	0	<0.05
Chronic inflammatory process	19%	0	<0.05
Infiltrative changes	15%	0	>0.05
Emphysematouschanges associated with inflammatory process	5%	0	<0.001

Table 5. Percentage predicted lung function among exposed and unexposed subjects

Parameter	Exposed (n=170)	Unexposed (n=130)	*p*-Value
VC	85.6 ± 25.2*†	103.2 ± 31.4	0.001
FVC	84.2 ± 21.1*	105.3 ± 24.9	0.0001
FEV_1	87.8 ± 22.2*	121.9 ± 31.5	0.0002
PEF	80.6 ± 32.1*	115.8 ± 34.3	0.04
FEF	95.2 ± 27.2 *	132.4 ± 52.6	0.0004
FEV_1/FVC	96.7 ± 7.2	111.4 ± 18.1	0.41
FEV_1/VC	89.1 ± 21.2	123.3 ± 36.0	0.62

* Significantly different from referent value (Student's *t* test, $p<0.05$). †% predicted lung function=% observed / predicted.

Based on the available data, it is evident that there exist little, if any, socioeconomic and demographic disparities between the individuals exposed to cement and those who were not exposed. This may be attributed to the fact that both groups were employed in the same industry and had nearly equal characteristics in terms of yearly income, level of education, age, gender, ethnic background, and other relevant factors. Furthermore, it is worth noting that none of the participants had a previous medical or familial background of respiratory disorders or any prior chest surgeries or traumas.

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Given the absence of notable disparities in key confounding variables such as age, cigarette smoking, past medical history, family history, socioeconomic status, and ethnic factors, it is plausible to attribute the observed declines in pulmonary function parameters, heightened prevalence of respiratory symptoms, and abnormal radiographic findings directly to exposure to cement dust. In light of the fact that both the dust exposed and unexposed participants had an equivalent duration of smoking, it is improbable that cigarette smoking can be attributed as the underlying cause for the disparities in symptoms seen between these two groups.

Research on long-term alterations in lung function among cement workers has shown inconsistent findings. Several investigations have demonstrated a greater incidence of respiratory symptoms and different levels of airflow obstruction in males who have been exposed to Portland cement dust [4, 13–15]. On the other hand, several studies have shown inconclusive results regarding the variations in pulmonary function measures and/or the occurrence of respiratory symptoms among cement workers in comparison to other blue-collar employees who share comparable smoking habits [7, 16, and 17]. The results of our study suggest that there is a prevailing inclination for some indices of lung function to decrease in size as a result of prolonged exposure to cement dust.

Respiratory tract problems, which constitute a significant category of occupational illnesses within the cement industry, arise from the inhalation of particulate matter suspended in the air. Chronic bronchitis, which is commonly linked with emphysema, has been documented as the prevailing respiratory ailment [3]. Moreover, it has been asserted that the most significant hazards for cement workers are silicosis and mixed dust pneumoconiosis [18]. While it is commonly recognized that regular Portland cement, with its low silica concentration, does not often lead to the development of silicosis, there is a potential risk of silicosis when individuals are exposed to raw materials that exhibit significant fluctuations in free silica content. In comparison to the referent subjects, the employees at the facility were subjected to notable levels of cement dust (as indicated in Table 1), which were many times greater than the prevailing standards. In line with previous research [1, 4, 7, 9, 13–15], our study found a higher occurrence of respiratory symptoms (such as cough, phlegm, dyspnea, and wheezing) among the employed population, as indicated in Table 3. Likewise, previous studies have documented that occupational exposure to cement dust is associated with a decline in ventilatory capabilities [4, 9, 19, and 20]. Based on the aforementioned observations, it is evident that the inhalation of cement dust led to a notable decline in some indicators of pulmonary function, including vital capacity (VC), forced vital capacity (FVC), forced expiratory volume in one second (FEV1), forced expiratory flow between 25% and 75% of the FVC (FEF25–75%), and peak expiratory flow (PEF) (as presented in Table 5). Nevertheless, there was no observed substantial disparity in the ratios of forced expiratory volume in one second to vital capacity (FEV1/VC) and forced expiratory volume in one second to forced vital capacity (FEV1/FVC). This data suggests that individuals who are exposed to cement dust in their profession are likely to experience mild levels of restrictive ventilatory dysfunction. This discovery aligns entirely with the perspectives presented by Kumar et al., which suggest that in cases of restrictive pulmonary disorders, there is a decrease in forced vital capacity (FVC), but the expiratory flow rate, often assessed using forced expiratory volume in one second (FEV1), remains either normal or decreases correspondingly. Therefore, the ratio of forced expiratory volume in one second (FEV1) to forced vital capacity (FVC) is approximately within the range of normal values [21]. The findings of this study indicate that workers who were exposed to the specified conditions had a notably elevated prevalence of pulmonary emphysema and other radiographic abnormalities in comparison to their counterparts who were not exposed. This conclusion is consistent with other research that have also observed elevated incidence of chronic bronchitis and pulmonary emphysema among cement workers in comparison to the general population.

Conclusion

In summary, the findings presented in this study offer additional support for the hypothesis that occupational exposure to cement dust is linked to respiratory symptoms, radiographic alterations, and functional impairments. The findings presented here, which align closely with our initial observations [23], provide additional support for the necessity of utilizing adequate personal protective equipment during work activities. Moreover, they underscore the importance of implementing effective ventilation systems to minimize or eliminate dust exposure. These measures are crucial in safeguarding workers against the potential development of more severe chronic respiratory conditions in the long term.

References

1. Kalacic I: Chronic nonspecific lung disease in cement workers. Arch Environ Health 27, 78–83 (1973)
2. Rom WN. Silicates and benign pneumoconiosis. In: Rom WN, ed. Environmental and Occupational Medicine, 3rd ed. New York: Lippincot-Raven, 1998: 587–599.
3. Pordan L, Bachofen G. Cement and concrete. In: Stellman JM, ed.

Encyclopaedia of occupational health and safety, 4th ed. Geneva: International labor organization, 1998: 93.44–93.49.

4. Yang CY, Huang CC, Chiu HF, Chiu JF, Lan SJ and Ko YC: Effects of occupational dust exposure on the respiratory health of Portland cement workers. J Toxicol Environ Health 49, 581–588 (1996)

5. Abrons HL, Peterson MR, Sanderson WT, Engelberg AL and Harber P: Chest radiography in Portland cement workers. J Occup Environ Med 39, 1047–1054 (1997)

6. Pauzi, A. N., Muhammad, N., Sairi, N. H., Putra, T. T., Gul, M. T., Rahim, N. F. A., ... & Abdullah, N. 2019. The effect of different solvent extraction towards antiurolithiatic properties of *Euphorbhia hirta* and *Orthosiphon stamineus*. In *IOP Conference Series: Earth and Environmental Science* (Vol. 269, No. 1, p. 012040). IOP publishing.

7. Gul, M. T., Dheyab, A. S., Shaker, E. K., Muhammad, N., & Pauzi, A. N. 2020. In vitro evaluation of anti-urolithiatic properties of *Strobilanthes crispus* extracted using different solvents. *Research Journal of Chemistry and Environment. Vol, 24*, 1.

8. Gul, M. T., Muhammad, N., Pauzi, A. N., Bakar, M. F. A., Talip, B. A., Abdullah, N., ... & Ibrahim, N. 2021. Evaluation of *Phyllanthus niruri* L. from Malaysia for In-vitro Anti-Urolithiatic Properties by Different Solvent Extraction: Properties of Anti-Urolithiatic. *Biological Sciences-PJSIR*, *64*(1), 81-86.

9. Rahim, N. F. A., Muhammad, N., Putra, T. N. M. T., Marzuki, W. N. A. S. W., Abdullah, N., Talip, B. A., ... & Gul, M. T. 2019. Antioxidant Activity and its Interaction Effect on Polyherbal Formulations of *Nephrodium inophyllum, Polygonum minus Annona squamosal* L. and *Stevia rebaudiana*. *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences*, *61*(1), 1-9.

10. Rahim Gul, H. U. J., Gul, M. T., Khan, M. A., Malik, A., Jan, S., Rafiullah, A. S. D., & Muhammad, N. 2019. In-vivo pharmacological investigation of root extract of *Myrtus communis* L. by using Animal model (Mus musculus). *In-vivo*, *4*(1).

11. Jan, H. U., Saeed, A., Parveen, G., Mukhtar, N., Siraj, M., Sami, A., & Gul, M. T. 2023. Pharmacognostic Study of *Ehretia acuminata* R. Br. *Proceedings of the Pakistan Academy of Sciences: B. Life and Environmental Sciences*, *60*(2), 267-272.

12. Zareef, H., Gul, M. T., Qureshi, R., Aati, H., & Munazir, M. 2023. Application of ethnobotanical indices to document the use of plants in traditional medicines in Rawalpindi district, Punjab-Pakistan. *Ethnobotany Research and Applications*, *25*, 1-29.

13. Meo SA: Chest radiological findings in Pakistani cement mill workers. Saudi Med J 24, 287–290 (2003)

14. Abrons HL, Peterson MR, Sanderson WT, Engelberg AL and Harber P: Symptoms, ventilatory function, and *J Occup Health, Vol. 49, 2007*

15. environmental exposures in Portland cement workers. Br J Ind Med 45, 368–375 (1988)

16. Vestbo J and Rasmussen FV: Long-term exposure to cement dust and later hospitalization due to respiratory disease. Int Arch Occup Environ Health 62, 217–220 (1990)

17. Al-Neaimi YI, Gomes J and Liold OL: Respiratory illnesses and ventilatory function among workers at a cement factory in a rapidly developing country. Occup Med 51, 367–373 (2001)

18. Lemen R, Bingham E. Silica and silica compounds. In: Bingham E, Cohrssen B, Powell CH, eds. Patty's Toxicology, 4th ed. New York: John Wiley & Sons, 2001: 415–460.

19. Ferris BG: Epidemiology standardization project. Part 2 of 2. Am Rev Respir Dis 118, 1–120 (1978)

20. American Thoracic Society: ATS statement-snowbird workshop on standardization of spirometry. Am Rev Respir Dis 119, 831–838 (1979)

21. Noor H, Yap CL, Zolkepli O and Faridah M: Effects of exposure to dust on lung function of cement factory workers. Med J Malaysia 55, 51–57 (2000)

22. Meo SA, Azeem MA, Ghori MG and Subhan MM: Lung function and surface electromyography of intercostals in cement mill workers. Int J Occup Med Environ Health 15, 279–287 (2002)

23. Mwaiselage J, Bratveit M, Moen B and Mashalla Y: Cement dust exposure and ventilatory function impairment: an exposure-response study. J Occup Environ Med 46, 658–667 (2004)

24. Rasmussen FV, Borchsenius L, Holstein B and Solvsteen P: Lung function and long-term exposure to cement dust. Scand J Respir Dis 58, 252–264 (1977)

25. Fell AK, Thomassen TR, Kristensen P, Egeland T and Kongerud J: Respiratory symptoms and ventilatory function in workers exposed to Portland cement dust. J Occup Environ Med 45, 1008–1014 (2003)

26. Short SR, Petsonk EL. Respiratory system: the variety of pneumoconioses In: Stellman JM, ed. Encyclopaedia of occupational health and safety, 4th ed. Geneva: International Labor Organization, 1998: Vol. 1, 10.66– 10.69.

27. Ali BA, Ballal SG, Albar AA and Ahmed HO: Post- shift changes in pulmonary function in cement factory in eastern Saudi Arabia. Occup Med 48, 519–522 (1998)

28. AbuDhaise BA, Rabi AZ, al Zwairy MA, el Hader AF and el Qaderi S: Pulmonary manifestations in cement workers in Jordan. Int J Occup Med Environ Health 10,

417–428 (1997)
29. Kumar V, Cotran R and Robbins S: Basic pathology, 5th ed. Philadelphia: WB Saunders Company, 1997: 393–425.
30. Vyskocil J: The problem of chronic bronchitis in cement workers. Rev Czech Med 8, 38–52 (1962)
31. Neghab M and Kamalee Neya M: Studies of work- related respiratory morbidity among employees of a cement industry in Shiraz, Iran. Toxicol Lett 144 (Suppl. 1), s105 (2003)