Health Risk Assessment of Marble Dust at Marble Workshops

M. I. El-Gammal[1], M. S. Ibrahim[1], El-Sayed A. Badr[1], Samar A. Asker[2] and Neven M. El-Galad[1].

[1]Environmental Science Department, Faculty of Science, Damietta Branch, Mansoura University, Mansoura, Egypt
[2]Histology and Cell Biology Department, Faculty of Medicine, Mansoura University, Mansoura, Egypt

Abstract: Marble workers are occupationally exposed to intense environmental marble dust in their workplace. The main objective of this study is to evaluate health risk assessment that might generate from marble manufactures in Damietta City. We also aimed to investigate the effect of marble dust exposure on lugs of rats. The rats exposed to inhalation of dust induced pathological changes in their lungs which involved the different tissue constituents. The degree of these pathological changes was proportional to the duration of exposure. This study shows positive relationships between respiratory lesions and marble dust. The mean concentrations of inhalable dust in marble workshops (A,B,C) were 30.44, 60.41, 68.73 mg/m^3 respectively, whereas The mean concentrations of personal respirable dust in marble workshops (A ,B and C) were 6.10, 6.92, 7.15 mg/m^3 respectively. Most of these measurements were exceeded the permissible exposure limit. Moreover, the data of the present study demonstrated that long period of chronic exposure to dust induced progressive atrophic changes in the alveoli of rats. Therefore, there are some potential risk of such industry lying on the environmental, which requires attention, mitigations, and management to protect the existing human and animal health.

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1. Introduction

Marble has been commonly used in the sculpturing of statues, the construction of buildings and monuments since the ancient times. It is a material used in tiles, countertops and indoor flooring. The industry's disposal of the marble powder material, consisting of very fine powder, today constitutes one of the environmental problems around the world **(Corinaldesi *et al.,* 2010).** One of the major waste generating industries is the marble quarry and production industry by which around 70% of this precious mineral resource is wasted in the mining, processing, and polishing procedures. Around 40% of marble waste is generated world widely during quarrying operations in the form of rock fragments and being dumped either in nearby empty pits, roads, riverbeds, pasturelands, agricultural fields, or landfills leading to wide spreading environmental pollution **(Çelik, 1996; Akbulut and Gürer, 2003).**

Marble is a metamorphic rock composed of recrystallized carbonate minerals, most commonly calcite or dolomite **(Kearey, 2001).** Workers who quarry, grind, polish and install marble are exposed to the dust, which contains particles of calcium carbonate and silica. Prolonged exposure to respirable crystalline silica has long been known to cause one of the oldest known industrial diseases, silicosis **(Pilkington *et al.,* 1996**; **Tjoe-Nij *et al.,* 2003).** In addition to silicosis, respirable crystalline silica has been associated with autoimmune disease **(Parks *et al.,* 1999),** non-malignant renal disease **(Steenland and Sanderson, 2001**), cardiac opestractive disease (COPD) **(Hnizdo and Vallyathan, 2002)** and lung cancer **(IARC, 1997)**. Health risks are associated with exposure to marble dust.

The manufacturing of marble involves cutting and finishing marble obtained from quarries, where specific dimensional marble is prepared for various uses in specialized mills equipped with saws, polishing machines, and others. Marble sawing equipment includes large circular saws, where various types of diamond and other equipment are used for smoothing, polishing, and edging the raw marble. The marble production process includes several steps. Marble blocks are cut into smaller blocks in order to give them the desired smooth shape. During the cutting process about 25% the original marble mass is lost in the form of dust.

Processing of marble results in the formation of marble dust, which is suspended in the air and may then, is inhaled by the workers. Epidemiological studies indicates that workers exposed to marble dust stand an increased risk of suffering from asthma symptoms, chronic bronchitis, nasal inflammation and impairment of lung function **(Camici *et al.,* 1978 Angotzi *et al.,* 2005; Leikin *et al.,* 2009).**

The affected workers were having body problems like headache, backache and stressed due to under- payment. Individuals having papilloma have faced problem at work like noise, dust or fumes and poor maintenance of equipment **(Dagli *et al.,* 2008)**.

Currently, Egypt has about 500 marble and granite factories. 400 factories or about 70% of the industry is located in Shak El Thoban in Katameyya, Cairo. The remaining 100 factories are scattered all over Egypt **(Kandil and Selim, 2006)**.

The study was conducted at Damietta City of the capital of Damietta Governorate at the Northeast Egypt. It is counts with almost one million inhabitants; it is an old city with long history. As Damietta City is a commercial city with extensive economic activity, is based on the different activities of furniture work-shops including painting and marble workshops, in addition to numerous numbers of small industrial activities as Company for textile and weaving and Egyptian Company for Diary.

In addition, there are about 169 marble manufacturing plants of small and medium sized enterprises, which are scattered within Damietta City, and often occupy the ground floor of the building, where the streets are very narrow and located in densely populated metropolitan areas. About 845 laborers work in these workshops with an average of about 4-6 persons per a workshop; with lack of workplace dust control, ventilation and personal protection. They used also equipments with no fitted extraction ventilation.

The main objectives of this study are to evaluate risk health assessment that might generate from marble manufactures in Damietta City. We also aimed to investigate the effect of marble dust exposure on lungs of rats.

2. Materials and Methods

Raw material of these workshops is marble only and this widely found on the earth's crust and with no risk running out in nature, the raw blocks extracted from quarries and are then processed into split, sawn or polished slabs and stone blocks then give the soft finish surface by sawing process. Pollution problems resulting from the working processes of marble is predominantly dust generation and noise from the mechanical operations **(Angotzi *et al.,* 2005).**

Environmental Measurements
Sampling and analysis of Marble Dust

Three marble workshops (A, B, C) were randomly selected in Damietta City for this study. Most of the selected workshops depend on the natural ventilation that varies from one to nine openings just four of selected workshops use exhaust ventilation. Workers in all workshops have never worn respirators.

Exposure to marble dust concentration
Measurement of Marble Dust

During 15 consecutive weeks, 4 inhalable marble-dust samples were measured daily for each of the three marble workshops (A, B and C) twice per week. A total of 360 inhalable particulate samples were collected on whatman glass fiber filter (pore size 0.45µ, diameter 47mm), using an open face holder, connected to sampling pump operating for 8hr at a height of 1.5 m above the ground level during workday. The flow rate of the portable pumps was calibrated to 1.5 L/min.

Potential Health Impacts

In the present study, a total of 360 personal respirable marble dust measurements were performed on 12 non smokers marble workers selected randomly from three marble workshops (A, B and C); 150, 120 and 90 samples were performed on 5 workers at (A), 4 workers at (B) and 3 workers at (C), respectively. The age of workers ranged from 16 to 50 years, with mean of 33 years and continues in their work since 5 to 35 years, during which they are exposed to these pollutants.

Personal respirable marble dust samples were collected for 8hr on Cellulose membrane filters (pore size 0.45µm, diameter 25mm), supported in aluminum cassettes and were weighed to an accuracy of 10-4 using an electrobalance, within the cassettes before and after sampling. The flow rate of the portable pumps was calibrated to 1 L/min. The filter is about 100 % efficiency for particle 0.1 µm **(Harrison and Perry, 1986)**.

Experimental Animal

A total of 40 adult albino male rats were individually restrained in stainless steel holders; the restrainers were placed into the face plate of the exposure chamber. The rat respiratory system has been highly used as an experimental model for speech, since its shape is similar to the human respiratory system. 40 adult albino male rats with average body weight between 150-200 gm (Rattus norvergicus Wistar strain), aged 60 days (7 to 8 weeks of age), were used in this study, kept in cages and exposed to inhalation of the dust in marble workshops. Rats were randomly divided into three groups, sacrificed at survival periods 15, 90 and 115 days after exposure to dust inhalation in marble workshops (10 rats for each survival period) and 10 rats not ex-posed to dust (control group).

The lungs of each rat were dissected, cut into smaller pieces and fixed in 10% neutral buffered formalin over night at room temperature. Tissue samples were dehydrated in alcohols, cleared in xylol and embedded in hard paraffin. Tissue sections of 5um thickness were stained with haematoxylin and eosin **(Bancroft and Gamble, 2008).**

3. Results and Discussion

Evaluation of Inhalable and Respirable Marble-Dust Sampling

Tables (1 and 2) and figs. (1 and 2) represent the mean, maximum and minimum concentrations of inhalable and respirable marble dust at marble workshops (A, B and C) during 15 consecutive weeks (study period). The mean inhalable marble dust were (30.43 mg/m^3, 60.4 mg/m^3 and 68.7 mg/m^3), respectively. However, the mean concentrations of personal respirable marble dust at marble workshops (A, B and C) were (6.10, 6.92 and 7.15 mg/m^3), respectively.

For the marble workshop (A, B and C) the inhalable concentrations of marble dust samples ranged from (2.0 to 82.1 mg/m^3), (9.8 to 136.7 mg/m^3) and (8.4 to 115.3 mg/m^3), respectively. For the marble workshop (A, B and C) the personal respirable concentrations of marble dust samples ranged from (1.8 to 11.8 mg/m^3), (1.2 to 11.3 mg/m^3) and (1.4 to 11.3 mg/m^3), respectively. Most of measurements were exceeded the current exposure standard for dust (5 mg/m^3). The Dutch Expert Committee for Occupational Standards (DECOS) has recommended a health- based limit of 0.2 mg/m^3 to prevent irritation of eyes and of the respiratory tract, as well as to minimize the risk of occupational asthma and nasal allergies. It was noticed that the highest exposures have generally observed during sawing machine for cutting and emery machine for polishing and glossing the surface. The rising threats to the health of the workers and inhabitants residing near the marble quarries in Pakistan, and the workers and residents living in adjacent areas are prone to a disease called silicosis, whereby inhaled marble dust damages the cells of the respiratory system **(Zaman, 2008).**

For marble workshops, the maximum inhalable marble dust level involves cutting, polishing and finishing marble was 115.3 mg/m^3 at workshop (C), whereas, the maximum personal respirable marble dust was 11.8 mg/m^3 at workshop (A). However, the minimum inhalable marble dust was 2.0mg/m^3 at workshop (A),marble dust was 1.2 mg/m^3 at workshop (A and B). The coarsest dust size was produced during machining operations whereas the finest was detected when machines were not operating due to the removal of the coarsest fractions by gravity. Inhalable diameter particulate matter (IPM) sampling, with aerodynamic ranges for 0 - 100µm, is the environmental measurement which is the most closely predictive of the risk of developing nasal cancer **(Hinds, 1988).** It is the mass fraction of total airborne particle which is inhaled through the nose and mouth **(ISO, 1995).**

ACGIH (1991) has defined inhalable particulate mass (TLV- IPM) as those materials that are hazardous when deposited anywhere in the respiratory tract. Respirable mass sampling (RPM) should be used when the health concern is occupational asthma **(Hinds, 1988**; **Anto *et al.*, 2001).** Although inhalable dust exposures were high compared with the respirable dust exposures, some of the exposure effects were associated with the airways of lung.

The result of this marble dust level demonstrates that 2.22% of inhalable marble dust was lower than MAC (5mg/m³), and 3.05% of them was (5 < 10) above MAC value, 13.85% of them was (5<10) above MAC, 24.16% of inhalable marble dust level was 70<100 and 2.78% above MAC, (Table 3). Whereas, 8.05% of respirable marble dust was below MAC value, and 19% of them was equal to or above MAC. Moreover 71.67% of respirable marble dust was (5<10) above MAC and 5.27%respirable marble dust was (>100) above MAC. The mean inhalable dust for 360 samples was above MAC and for 325 samples was below MAC value. This result is in agreement with **Worksafe (1995)** and **El-Gammal (2005)** who found that the personal dust exposure often exceeds the current exposure standard.

Present study have demonstrated that, the high level of environmental pollution by marble dust level in all workshops studied was observed for workers not wearing respirators and the poor maintenance of ventilation systems at most workshops. Lack of awareness of potential health effects of marble dust exposure might have potential health hazards.

Since, only a small number of workshops had concentration of marble dust below the detection limit, it can be stated that almost all personal exposures were exposed to marble dust concentration higher than the MAC value.

Table (1) Means Concentration of Inhalable Marble Dust in Workshops (A,B,C) in mg/m^3 during 15 weeks.

Marble workshop	Mean Conc. Of inhalable dust	Maximum Conc. Of inhalable dust	Minimum Conc. Of inhalable dust
A	30.44	82.1	2.0
B	60.41	136.7	9.8
C	68.73	115.3	9.7

Table (2): Mean Concentrations of Personal Respirable Marble Dust in Workshops in mg/m3 during 15 Weeks.

Marble workshop	Mean Conc. Of personal respirable dust	Maximum Conc. Of personal respirable dust	Minimum Conc. Of personal respirable dust
A	6.10	11.8	1.2
B	6.92	11.3	1.2
C	7.15	11.3	1.4

Table (3): Range and Percentage of Concentrations of Inhalable Marble Dust in Workshops (A, B and mg/m^3 along the 15 Weeks along the Study Period.

Range	Inhalable Dust		
	No. of Samples	Range (mg/m^3)	Percentage (%)
< 5	8	2.0 - 4.8	2.22%
5 < 10	11	5.6 – 9.8	3.05%
10 < 30	59	10.4 – 29.7	16.39%
30 < 50	81	30.1 – 49.7	22.5%
50 < 70	104	50.2 – 69.8	28.89%
70<100	87	70.1 -99.5	24.16%
>100	10	102.2-136.7	2.78%
Total	360		

Table (4): Range and Percentage of Concentrations of Personal Respirable Marble Dust in Marble work-shops (A, B, and C) in mg/m^3 during 15 Weeks along the Study period.

Range	Personal Respirable Dust		
	No. of Samples	Range (mg/m^3)	Percentage (%)
1< 2	7	1.2-1.7	1.94%
2 < 3	21	2.1-2.9	5.83%
3< 4	26	3.1-3.9	7.22%
4< 5	29	4.2-4.9	8.05%
5 < 10	258	5.1- 9.9	71.67%
> 10	19	10.0-11.8	5.27%
Total	360		

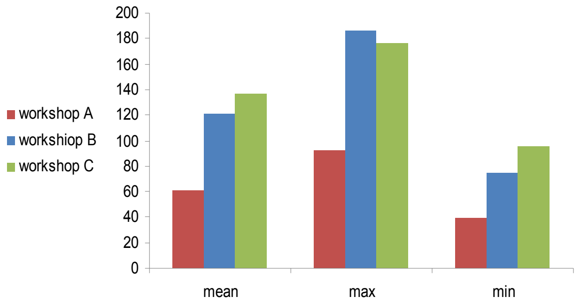

Figure 1: Mean, Maximum and Minimum Concentrations of Inhalable Marble Dust in Workshops (A, B and C)

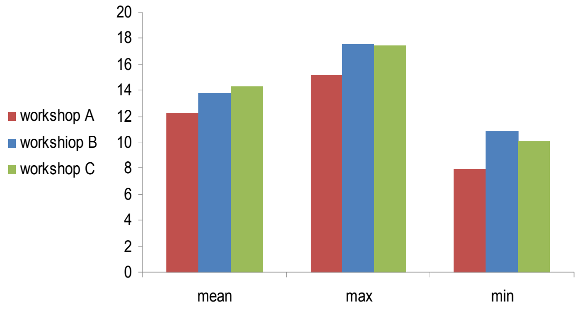

Figure 2: Mean, Maximum and Minimum Concentrations of Personal Respirable Marble Dust in Workshops (A, B and C).

Evaluation Impact of Marble Dust on exposed rats at marble Workshops

Histological changes:

In this prospective study, we observed an inverse relationship between lung in control rats and rats exposed to marble dust inhalation.

A-Group I (control rats):

The normal architecture of lung in control rats appeared formed of thin wall lined with flat epithelial cells separated by thin connective tissue septae (Figs. 3, 4). The alveoli and bronchioles illustrated the presence of intact alveoli, alveolar sacs and alveolar ducts with presence of bronchioles. The alveoli are lined by two types of cells; the main type is flat squamous epithelial cells sited on very thin basement membrane. The alveoli were separated by thin layers of connective tissue (C.T.) septae (Fig.4) while the bronchioles revealed the presence of ciliated columnar epithelial cells. The submucous layer appeared very thin containing blood vessels and lymphocytes and thin layer of C.T. corium (Fig 5).

B-Group Π (rats exposed to dust inhalation) were divided into three subgroups:

1-Group exposed to dust inhalation for 15 Days:

Induced minimal atrophic changes in the lining epithelium of the alveoli and bronchioles. Only there was minimal infiltration of C.T. septae and submucosae with few macrophages and lymphocytes (Figs. 6, 7), Few extravasated blood was detected (Fig. 7). The bronchioles inside the lungs showed also edematous C.T. changes (Fig. 8).

2- Group exposed to dust inhalation for 90 Days:

It was apparent an alveolar shrinkage and collapse associated with disruption and increased in thickness of the alveoli, alveolar sacs and distortion of alveolar ducts with broadening of the C.T. septae filled with huge amounts of macrophages (Fig. 9**)**

3- Group exposure to dust inhalation 115 Days Post-Exposure:

The alveoli displayed collapse and shrinkage causing narrowing of its lumen, widespread increased thickness of C.T. septae (Figs10). Disruption of the alveoli associated with increased number of phagocytic cell infiltrations in the septae were detected (Fig. 11). The pathological changes markedly increased in severity and extent. The epithelial alveolar cells and alveolar ducts manifested variable forms and degrees of pathological changes. Areas of granuloma appeared in tissue lungs (Figs.11 and 12) as well as marked degeneration of epithelium of bronchioles (Fig.13) as compared to control group and 15 days exposure. Also, showed areas of hyperplasia with signs of tumor cells.

The bronchioles exhibited relative reduction in submucosal layer with atrophied its lining epithelial layer with loss of its cilia, while the submucosal layer was edematous, widely spaced and contained abundant amounts of macrophages which markedly increased with the time of exposure (Figs. 13 and 14). There was also marked degenerative changes of alveolar epithelium covered with secretion and advanced increase in C.T. thickness (Fig. 14).

Histological examination:

This study showed that workers exposed to chronic inhalation of the dust in marble working processes showed prevalence rates of respiratory illness. The respiratory effects of exposure to occupation marble dust was more pronounced in the rats exposed to inhalation more than 115 days as revealed from the histological slides. This attributed to concentration of the dust and duration of exposure inducing respiratory impairment. These findings in agreement with investigators on the respiratory health effects of silica, who found reduction in all mean lung functions **(Kalacic, 1973; Valic and Zuskin, 1977 Choudat *et al.,* 1990; Pang *et al.,* 1992;).** They explained that progressive loss of lung function probably resulting from non specific airways disease and fibrosis become more prominent in smaller airways. Also, concomitant with findings of **Yoseph and Bekele (1998)** who revealed that individual developed reduced lung functions and respiratory symptoms in increased dust concentration and duration of exposure. They found that; Lung functions impairment in correlated with dust exposure, dust concentration and duration of exposure have a considerable bearing in producing decrease in lung functions, and occupational dusts have greater bearing on smaller airways than larger airways.

An important finding in the present study was distortion in the lining epithelium of respiratory bronchioles with areas of loss of its cilia and increased lymphocytic infiltrations which markedly increased with duration of exposure. In agreement to **Bennett *et al.* (1993) and Rusch *et al.* (1995)** who demonstrated early human bronchial neoplasia due to accumulation of P 53 protein.

Histological examination for slides of lung for rats exposed to marble inhalation revealed marked gradual increase in lymphocytic infiltration. Also, persistent changes included, distortion in epithelial lining of bronchioles and alveoli and presence of areas of degeneration which increased by day 100 after exposure.

This agreed with results obtained by **Dungworth *et al.* (2001)**, who recorded many types of morphological changes in the lungs of mice exposed to silica inhalation. These were inflammation, lymphatic infiltration, bronchio-alveolar hyperplasia as well as bronchioles and pulmonary fibrosis. Moreover, **Malkinson (1998) and Dragani *et al.* (2000)** mentioned that mice developed lung tumors resemble human lung adenocarcinoma.

Johnson *et al.* (2001) and Ress *et al.* (2003) found also hyperplasia and hypertrophy of alveolar epithelium in response to silica exposure in rats. They explained this because silica increase secretion of the product of alveolar type II cells, surfactant in exposed mice.

These finding supports the need to further investigate of marble dust exposure as possible carcinogenic particulate.

The data of the present study, demonstrated that long period of chronic exposure to dust induced progressive atrophic changes in the alveoli, the alveolar ducts are lined with interrupted flat epithelial cells, even collapse of the alveoli. The intera-alveolar septae showed C.T increase in thickness. Similar changes have been reported by **Mery *et al.* (1994) ; Monticello *et al.* (1996) and Calderon- Garciduenas *et al.* (1998).**

Rats have been utilized for the study of atrophy of epithelial lining the trachea, bronchioles and alveoli of their lungs after exposure to dust inhalation for different periods. The process of atrophy is variable in extent and intensity (**Morgan, 1991).** Several repeated exposure to inhaled chemical irritants caused degeneration, necrosis of surface epithelium, increased cell proliferation and even carcinoma in upper respiratory tract (**Monticello *et al*. 1996)**. While short exposures to pollutants an acute inflammatory response in the upper respiratory tract of humans **(Koren *et al.,* 1990 and Steerenberg *et al.*, 1996).**

There was marked infiltrations with macrophages, lymphocytes and extra-vasated blood in lung alveoli. This concomitant with studies of **Calderon–Garciduenas *et al.* (1997)** who mentioned presence of macrophages in nasal mucosa associated with vascular proliferation in children exposed to dust inhalation.

In a study in Hong Kong, this was addressed using visual scoring of emphysema at CT according to the extent of lung involvement **[Ooi *et al.,* 2003].**

In this work there were areas with identifiable respiratory epithelium cell hyperplasia and damaged cells. This was similar to findings of **Cheng *et al.* (1992)** who referred this due to oxidation of C8 guanine is a major mutagenic lesion, producing predominantly G-T transversion mutations.

Bascom *et al.* (1996) and Lee *et al.* (1997) reported also that respiratory epithelium in humans subjected to different air pollutants with potentially different mechanisms of DNA damage.

Stained sections with haemtoxylin and eosin revealed thickening of the alveolar septae, vascular extravasations and edema of the septae with hemorrhage in the interstitial tissues with marked proliferation of macrophage cells. This is concomitant with results obtained by **Taysee *et al.* (2005)** who found sever lung lesions secondarily to edema and intralveolar hemorrhage in the mice exposed to toxin botulinum inhalation. This was concomitant with researches of **Nikula *et al.* (1997)** who clarified increased thickness of interstitial septae in the lungs was due to accumulation of macrophages, giant cells, all lymphocytes and plasma cells causing micro-granulomas in the lungs of mice.

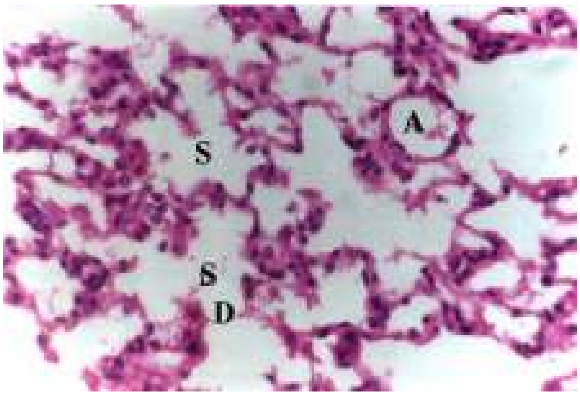

Figure (3): Micrograph of a paraffin section of control rat-lung, showing alveoli with thin walls (A) as well as alveolar ducts (D) and alveolar sacs(S). (H&E X 400)

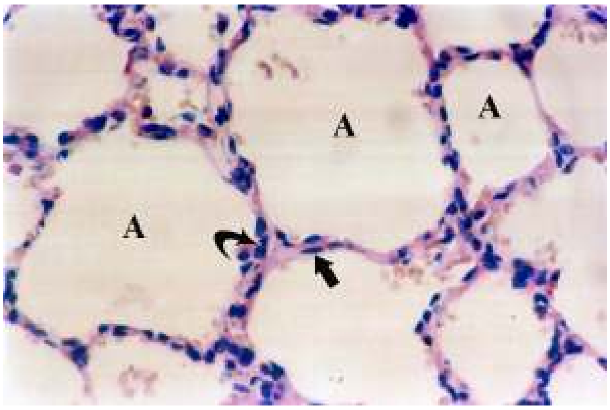

Figure (4): Micrograph of a paraffin section of control rat-lung, showing the alveoli (A) lined with flat epithelial cells (arrow) cubical cells (curved arrow). (H&E X 1000)

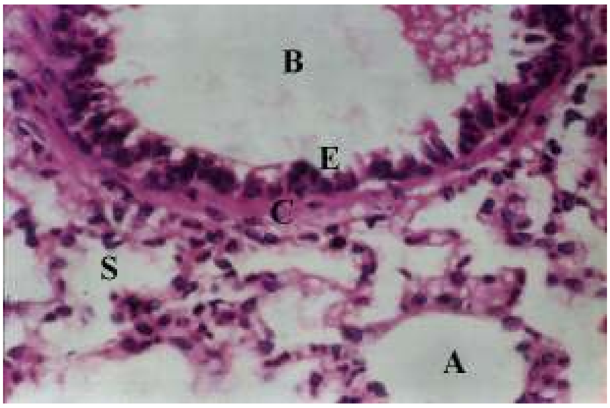

Figure (5): Micrograph of a paraffin section of control rat-lung, displaying bronchiole (B) composed of pseudostratified ciliated epithelial cells (E), intact layer of corium formed of intact connective tissues (c). Note: the alveoli (A) and alveolar sacs (S). (H&E X 400)

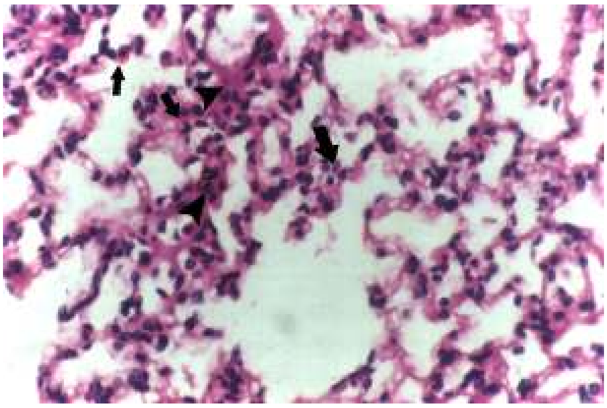

Figure (6): Micrograph of rat-lung 15 days post-exposure to dust, demonstrating thickened interalveolar connective tissue (arrowheads). Note, many macrophage (arrows) between the alveoli. (H&EX 400)

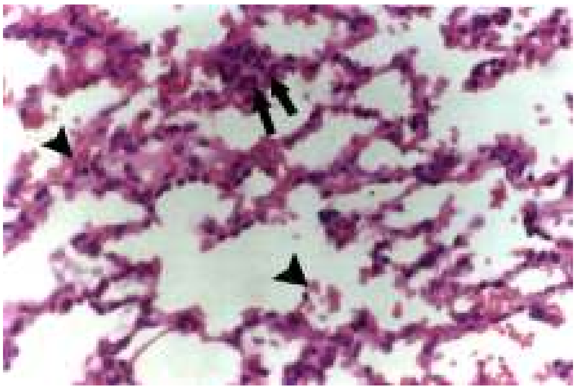

Figure (7): Micrograph of rat-lung 15 days post-exposure to dust, revealing thickened interalveolar connective tissue (arrows) and extravasuated blood cells (arrowheads). (H&E X 400)

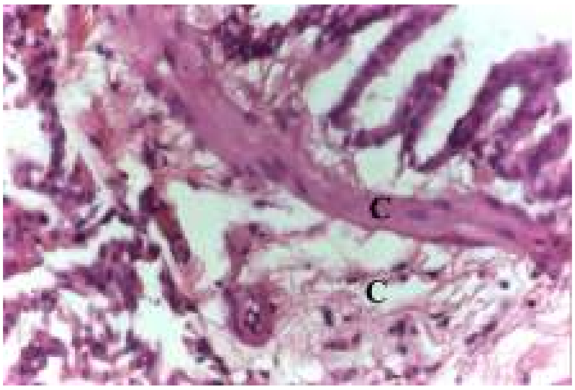

Figure (8): Micrograph of rat-lung 15 days post-exposure to inhalation, showing bronchiole with thick edematous connective tissue. (H&E X 400).

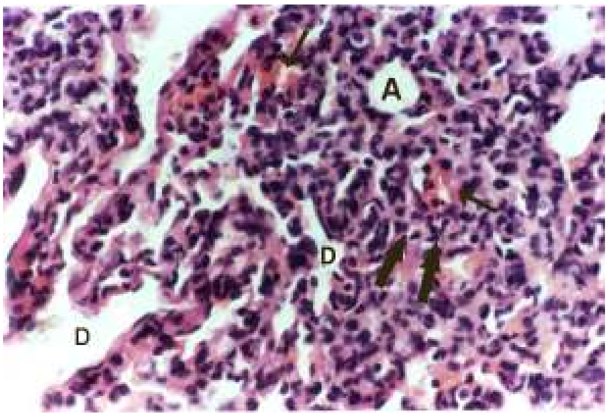

Figure (9): Micrograph of rat-lung 90 days post-exposure to dust inhalation, demonstrating collapsed alveoli (A) with thick lining epithelium, surrounded by thick C.T. septae filled with marvelous amounts of macrophages (Thick arrows) with extravasated blood cells (thin arrows). Note: distortion and collapse of alveolar ducts (D). (HX&E X 400)

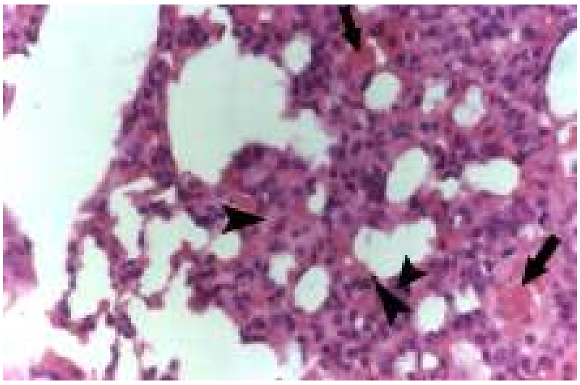

Figure (10): Micrograph of rat-lung 115 days post-exposure to dust inhalation, revealing marked increase in interalveolar connective tissue (arrow heads) and collapse in many alveoli . Note: hyaline degeneration in some areas (arrows). (H&E X 400)

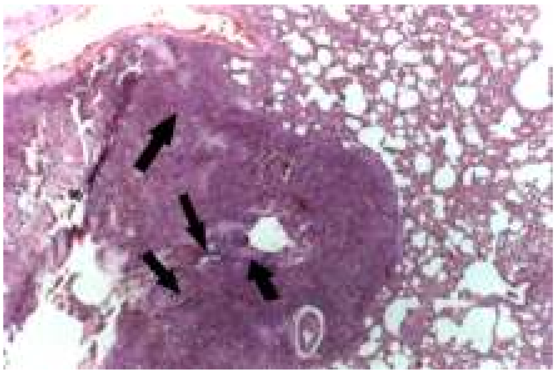

Figure (11): Micrograph of rat-lung 115 days post-exposure to dust inhalation, showing large degenerated ill defined area multifocal granuloma (arrows). (HX&E X 100)

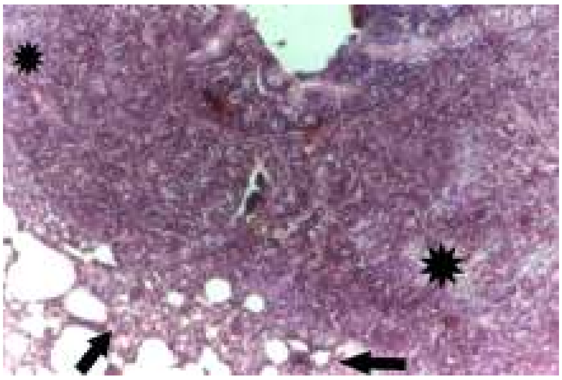

Figure (12): A higher magnification of the previous figure showing the degenerated granuloma (stars) and thick connective tissue septae between the alveoli (arrows). (H&E X 400).

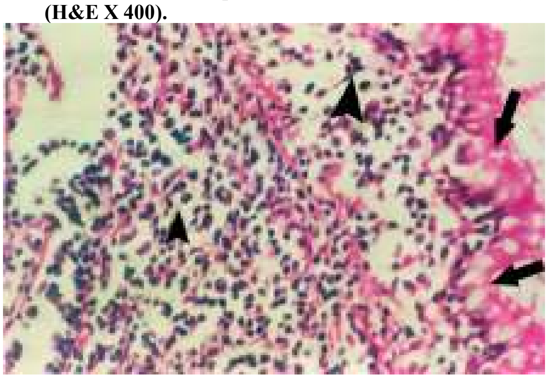

Figure (13): Micrograph of rat-lung 115 days post-exposure to dust inhalation, showing the bronchiole composed of degenerated epithelial layer (arrows), wide edematous submucosal layer infiltrated with inflammatory cells (arrow heads), (H&E X 400)

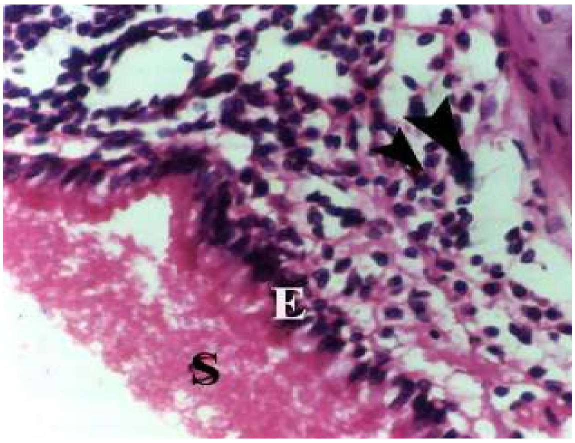

Figure (14): Micrograph of rat-lung 115 days post-exposure to dust inhalation, showing the bronchiole formed of degenerated, atrophied epithelial layer (E) covered with aggregation of secretion (S), the submucosal layer increased in thickness due to separated edematous C.T. which was hugely infiltrated by large amounts of macrophages (arrow heads). (HX&E X 400).

Conclusions

Marble production, as an industrial sector, has a great contribution to Damietta City gross national income due to both different activities of workshops (furniture and painting workshops), capacity and marble reserve.

However, there are some potential risk of such industry lying on the environment, which requires attention, mitigations, and management to protect the existing human and animal health. From environmental point of view, results indicated that marble industry has human impacts with environmental risks, however, marble workshops need an intensive evaluation to determine the certain norms to regulate their action and to control the possible impact produced. However, marble workshops must be established within industrial zones to prevent environmental-community inflects and to allow better safe competition. On the other hand, existing marble workshops have to introduce mitigation measures to minimize gradually the environmental impacts through providing

Recommendation

Generated dust during operation may affect human, plant and animal growth at the surrounding environment. Therefore, a management strategy should be implemented to avoid the negative impacts of dust contamination and to reduce the translocation of dust outside the workshops. To avoid respiratory or other problems caused by exposure to dust and lesions due to noise. Engineering control methods should be introduced. Some examples are:

- Use of wet processes
- enclosure of dust-producing processes under negative air pressure (slight vacuum compared to the air pressure outside the enclosure)
- Exhausting air containing dust through a collection system before emission to the atmosphere
- Exhaust ventilation should be used in workshops.
- Controlled disposal of solid waste and do not allow entering drains, sewers or watercourses.
- Use of personal protective equipment may be vital, but it should nevertheless be the last resort of protection. Personal protective equipment should not be a substitute for proper dust control in order to respiratory protection and should be used only where dust control methods are not yet effective or are inadequate.
- Direct skin contact should be prevented by gloves, wearing respiratory protection during clean up is very essential.
- Educational awareness programs for workers should be instituted about hazard of exposure to marble dust and on the use and maintenance of exhaust ventilation systems, and the use and maintenance of personal protective equipment for avoid risk of dust and noise.
- Marble dust can be used either to produce new products or as an admixture so that the natural sources are used more efficiently and the environment is saved from dumpsites of marble waste.
- Constructive city planning by the complete separation of industry and commercial work-shops activities and habitations should receive a much attention as a responsible solution for environmental improvement.
- The further studies including risk assessment should be carried out in the marble workshops and more research of exposure to marble dust, as related to nasal mucosa and trachea lesions of marble workers in order to prevent series nasal problems.

Corresponding author
Maie. I. El-Gammal
Environmental Science Department, Faculty of Science, Damietta Branch, Mansoura University, Mansoura, Egypt

References:

Akbulut H. and Gürer C. (2003). "The Environmental Effects of Waste Marble and Possibilities of Utilization and Waste Minimization by Using in the Road Layers". Proceeding of the fourth national marble symposium, Afyonkarahisar, December: 371– 8, Turkish.

American Conference of Governmental Industrial Hygienist (ACGIH), (1991). "Documentation of the Threshold Limit Values and Biological Exposure Indices". (5th Edn). Cincinnati, Ohio

Angotzi, G., Bramanti, L., Tavarini, D., Gragnani, M., Cassiodoro, L., Moriconi, L., Saccardi, P., Pinto, I., Stacchini, N. and Bovenzi, M. (2005). "World at Work: Marble Quarrying in Tuscany". Occup. Environ; 62: 417-421.

Anto J. M., Vermeire P., Vestbo J. and Sunyer J. (2001). "Epidemiology of Chronic Obstructive

Pulmonary Disease". European Respiratory J. 17: 982-994

Bancroft, J. D. and Gamble, M. (2008). "Theory and Practice of Histological Techniques".6th ed., Philadelphia, PA Churchil Livingstone. p. 126.

Bascom, R., Bromberg, P. A. and Costa, D. A. (1996). "Health Effects of Outdoor Air Pollution". I. Am. J Respir. Crit. Care Med. 153: 3-50.

Bennett, W. P., Colby, T. V., Travis, N. D., Borkowski, A., Jones, R. J., Lane, D. P., Metcalf, R. A., Samet, J. M., Takeshima, Y. and Gu, J. R. (1993). "P53 Protein Accumulates Frequently in Early Bronchial Dysplasia". Cancer Res.; 53: 4817-4822.

Calderon – Garciduenas, L., Osnaya, N., Rodriguez – Alcaraz, A. and Villarreal – Calderon, A. (1997). "DNA Damage in Nasal Respiratory Epithelium from Children Exposed to Urban Pollution". Environ. Mol. Mutagen; 30: 11-20.

Calderon-Garciduenas, L., Rodriguez-Alcaraz, A., Villarreal-Calderon, A., Lyght, O., Janszen, D. and Morgan, K. T. (1998). "Nasal Epithelium as a Sentinel for Airborne Environmental Pollution". Toxicological sciences; 46: 352-364.

Camici, G., Castagna, P., Leva, G., Messina, S., Poletti, G. F. and Vergazzoli, P. C. (1978). "Environmental Health Risk Working shop". Ann Ist. Super Sanita; 14 (3):547.

Çelik, M. Y. (1996). "Recycling of Waste Marble". M. Sc.Thesis, Afyon Kocatepe University, Natural Science Institute, Department of Mining Engineering, Afyonkarahisar, Turkish.

Choudat, D., Erisch, C., Barrat, G., El Kholti, A. and Conso, F. (1990). "Occupational Exposure to Amorphous Silica Dust and Pulmonary Function". Br. J. Ind. Med.; 47: 763-766.

Corinaldesi, V., Moriconi, G. and Naik T. R. (2010). "Characterization of Marble Powder for its Use in Mortar and Concrete". Const. Build. Mat.; 24: 113-117.

Dagli, R. J., Kumar, S., Mathur, A., Balasubrimanyam, G., Duraiswamy, P. and Kulkarni, S. (2008). "Prevalence of Leukoplakia, Oral Submucous Fibrosis, Papilloma and its Relation with Stress among Green Marbles Mine Laborers, India". 13(11) : E687-92.

Dragani, T. A., Hirohashi, S., Juji, T., Kawajiri, K., Kihara, M., Ono-Kihara, M., Manenti, G., Nomoto, T., Sugimura, H., Genka, K., Yokota, J., Takahashi, T., Mitsudomi, T. and Nagao, M. (2000). "Population- Based mapping of Pulmonary Adenoma Susceptibility 1 Locus". Cancer Res.; 60: 5017-5020.

Dungworth, D. L., Rittinghausen, S., Schwartz, L., Harkema, J. R., Hayashi, Y., Kittel, B., Lewis, D., Miller, R. A., Mohr, U., Morgan, K. T., Rehm, S. and Slayter, M. V. (2001). "Respiratory System and Mesothelium. In International Classification of Rodent Tumors": The Mouse (U. Mohr, P. Greaves, N. Ito, C. C. Capen, J. F. Hardisty, P. H. Long, D. L. Dung- worth, Y. Hayashi, and G. Krinke, Eds.) WHO IARC, Springer, Berlin, Germany.

El-Gammal, M. I. (2005). "Exposure Impact Assessment for Wood Dust at Furniture Workshops in Damietta City, Egypt". J. Union Arab Biol., 24 (A): 127-149.

Harrison, R. M. and Perry, R. (1986). "Handbook of Air Pollution Analysis". Chapman and Hall, 2nd ed., London, New York, pp. 149-546.

Hinds, W. C. (1988). "Basis for Particle Size-Selective Sampling for Wood". Appl. Ind. Hyg. 3, 67- 72.

Hnizdo, E. and Vallyathan, V. (2002). "Chronic Obstructive Pulmonary Disease due to Occupational Exposure to Silica Dust: a Review of Epidemiological and Pathological Evidence". Occupational and Environmental Medicine, 60: 237-243.

IARC (1997). "Silica, Some Silicates, Coal Dust and Para-aramid Fibrils". International Agency for Research on Cancer: Lyon.

ISO (1995). "Air Quality Particle Size Fraction Definitions for Health Related Sampling". 1st ed. ISO 7708 (E). International standerd Organization, Genva.

Johnson, L., Mercer, K., Greenbaum, D., Bronson, R. T., Crowley, D., Tuveson, D. and Jacks, T. (2001). "Somatic Activation of the K-Rasoncogene Causes Early Onset Lung Cancer in Mice". Nature; 410: 1111–1116.

Kalacic, I. (1973). "Chronic Nonspecific Lung Disease in Cement Workers". Arch. Environ. Health; 26:78-83.

Kandil, A. I. and Selim, T. H. (2006). "Characteristics of Marble Industry in Egypt: Structure, Conduct, and Performance". International Business and Economics Research Journal; 4 (3): 2-33.

Kearey, P. (2001). Dictionary of Geology, Penguin Group, London and New York, p. 163. ISBN 978-0-14-051494-0

Koren, H. S., Hatch, G. E. and Graham D. E. (1990). "Nasal Lavage as a Tool in Assessing Acute Inflammation in Response to Inhaled Pollutants". Toxicology; 60: 15-25.

Lee, J-G., Madden, M. C., Hatch, G., Bottei, G., Peden, D., Adler, K. and Devlin, R. (1997). "Ozone – Induced DNA Single Strand Breaks in Human and Guinea Pig Lung Cells in Vivo". Inhalation Toxicology; 9: 811-828.

Leikin E, Zickel-Shalom K, Balabir-Gurman A, Goralnik L, and Valdovsky E (2009). "Caplan's

Syndrome in Marble Workers as Occupational Disease". Harefuah 148: 524–526.
Mery, S., Larson, J. L., Butterworth, B. E., Wolf, D. C., Harden, R. and Morgan, K. T. (1994). "Nasal Toxicity of Chloroform in Male F344 Rats and Female B6C3F1 Mice Following a 1-Week Inhalation Exposure". Toxicol. Appl. Pharacol.; 125:214-227.
Monticello, T. M., Swenberg, J. A., Gross, E. A., Leininger, J. R., Kimbell, J. S., Seilkop, S., Starr, T. B., Gibson, J. E. and Morgan, K. T. (1996). "Correlation of Regional and Nonlinear Formaldehyde - Induced Nasal Cancer with Proliferation Populations of Cells". Cancer Res; 56: 1012-1022.
Morgan, K. T. (1991). "Approaches to the Identification and Recording of Nasal Lesions in Toxicology Studies". Toxicol. Pathol.; 19: 337-351.
NiKula, K. J., Swafford, D. S., Hoover, M. D.; Tohulka, M. D. and Finch, G. L. (1997). "Chronic Granulomatous Pneumonia and Lymphocytic Responses Induced by Inhaled Beryllium Metal in A/J and C3H/HeJ Mice". Toxicological Pathology, 25(1): 1-12.
Ooi, G. C., Tsang, K. W. T., Cheung, T. F., Khong, P. L., Ho, I. W. T, Ip, M. S. M., Tam, C. M., Lam, W. K., Chan, F. L. and Chan-Yeung, M. (2003). "Silicosis in 76 Men: Qualitative and Quantitative CT Evaluation – Clinical Radiologic Correlation Study". Radiology, 228: 816-825.
Pang, D., Fu S. c. and Yeng, E.C. (1992). "Relation between Exposure to Respirable and Silicosis in a Tungsten Mine in Chins". Br. J. Ind. Md.; 49: 38-40.
Parks, C. G, Conrad, K. and Cooper, G. S. (1999). "Occupational Exposure to Crystalline Silica and Autoimmune Disease. Environmental Health Perspectives, 107: 793-802.
Pilkington, A., Maclaren, W., Searl, A., Davis, J. M. G., Hurley, J. E., Soutar, C. A., Pairon, J. C., and Bignon, J. (1996). "Scientific Opinion on the Health Effects of Airborne Crystalline Silica". IOM report TM/95/08. Edinburgh, Institute of Occupational Medicine. Ref Type: Report
Ress, N. B., Chou, B. J., Renne, R. A., Dill, J. A., Miller, R. A., Roycroft, J. H., Hailey, J. R., Haseman, J. K. and Bucher, J. R. (2003). "Carcinogenicity of Inhaled Vanadium Pentoxide in F344/N Rats and B6C3F1 Mice". Toxicol. Sci.; 74: 287–96.
Rusch, V., Klimstra, D., Linkov, I. and Dimitrovsky, E. (1995). "Aberrant Expression of P53 or the Epidermal Growth Factor Receptor is Frequent in Early Bronchial Neoplasia and Co-expression Precedes Squamous Cell Carcinoma Development. Cancer Res.; 55: 1365-1372.
Steenland, K. and Sanderson, W. T. (2001). "Lung Cancer among Industrial Sand Workers Exposed to Crystalline Silica". American Journal of Epidemiology, 153: 695-703
Steerenberg, P. A., Fischer, P. H., Gmelig, M. F, Willighagen, J., Geerse, E., van de Vliet, H., Ameling, C., Boink AB., Dormans, J. A., van Bree, L. and van Loveren, H. (1996). "Nasal Lavage as a Tool for Health Effect Assessment of Photochemical Air Pollution". Hum. Exp. Toxicol.; 15: 111-119.
.Taysee, L., Daulon, S., Calvet, J. H., Delamanche, S., Hilaire, D., Bellier, B. and Breton, P. (2005). "Induction of Acute Lung Injury after Intranasal Administration of Toxin Botulinum a Complex". Toxicol Pathol; 33 (3): 336-342.
Tjoe-Nij, E., Burdoff, A., Parker, J., Attfield, M., Van Duivenbooden, C. and Heederik, D. (2003). "Radiographic Abnormalities among Construction Workers Exposed to Quartz Containing Dust. Occupational and Environmental Medicine, 60: 410-417
Valic, F. and Zuskin, E. (1977). "Respiratory Function Change in Textile Workers Exposed to Synthetic Fibers". Arch Environ. Health; 32: 383-387.
Yoseph, A. M., and Bekele, A. (1998). "Relative Chronic Effects of Different Occupational Dusts on Respiratory Indices and Health of Workers in Three Ethiopian Factories". American Journal of Industrial Medicine, 34:373-380.
Zaman, M. D. (2008). article featured in the March 7, 2008, online issue of the "Daily Times," an English language Pakistani newspaper.
Worksafe (1995). "Exposure Standard for Atmospheric Contaminants in the Occupational Environment". Australia Government Publishing Service. Canberre, Australia.