Prevalence of the occupational respiratory symptoms and hematological changes age wise and sex wise in labourers of cement industries in Tadipatri Mandal of Anantapur, A.P.

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SUMMARY

Investigation has been made on the respiratory disorders in male and female labourers of age groups 20-35 (younger), 36-45 (middle) and 46-55 (older) years of cement industries in Tadipatri Mandal of Anantapur district. Clinical data were established with the case study on history and clinical symptoms. This clinical database was prepared based on the survey conducted among 18515 long-term exposed groups of labourers. Much attention was paid to bring the correlation between smoking habit and occupation exposure response of respiratory system among labourers of three age groups. The major respiratory symptoms prevalent were dysponea (78.79%), asthma (22.77%) and cough (productive and non-productive cough) (23.50%). Dysponea (23.50%) was identified as major symptom in males and asthma (28.04%) in females. Middle age group of male labourers (41.65%) and younger age group of female labourers (46%) were the major suffers due to repeated long term exposure; prevalence of developing asthma (69%) was more in younger and middle age group of male labourers. Chronic cough (13.53%) was the common symptom in both sexes exposed to dust and male labourers were at higher risk for developing productive cough and attacks of dysponea. Incidences of respiratory symptoms were high in females than males, after adjusting for age and smoking habit. Comparative study of blood samples between the exposed and control revealed significant variation with reference to differential leukocyte count in particular eosinophils count in middle age group of male and female labourers, especially in older age group of female subjects, sharp rise of eosinophils was noticed. Eosinophilia in hyper responsive subjects significantly increased the risk to develop one or more respiratory symptoms.

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The cement industry in Anantapur district comprises mainly two major plants in private sector with an installed capacity of 2000 tones per day (tdp). The major raw materials required for the industry are limestone, clay, coke and gypsum. The raw materials are procured with in the industry mining belt, except the coke. The major environmental issues of the cement industry are gaseous emissions (from kiln containing particulate matter, CO_2 NOX, SO_2, etc), dust emissions (raw mill, conveyor transfer points and packing unit) fugitive emissions (refuse burning of tires and blasting of mines) and occupational safety and health.

Composition of cement includes lime, alumina, silica and iron oxide as tetra calcium alumino ferrate (4Cao,Al203), tricalcium aluminate (3Cao, Al2o3), tricalcium silicate (3Cao.Sio2) and dicalcium silicate (2Cao.Sio2). Small amounts of magnesia (MgO) Na, K, and S are also present. The pH of the cement in wet solution was alkaline within the range of 12.5-13.5. Aerodynamic diameter of cement particulate matter ranged from 0.05 to 5.0µm.

No studies were earlier made on the occupational health hazards of the labourers of this industry. Hence, the present study was carried out in labourers of males and females of three age groups such as 20-35, 36-45 and 46-55 attending Government Medical College Hospital in Anantapur who are working in cement factories. A hospital based survey was taken up to eliminate *healthy workers effect* (Helga and Levis, 1987). (Selection of workers with better health by pre-placement examination).

This study was aimed at investigating the relation between occupational cement dust exposure and acute as well as chronic respiratory health effect. The information will be valuable for the cement industry in order to promote the respiratory health of the workers.

MATERIALS AND METHODS

Study area:

The present studies were conducted in

Government Medical College hospital, Anantapur and working area of labourers in cement factories of Tadipatri. This factory is located in Bogasamudram which is about 12 Km on the outskirts of Tadipatri and it has work force of about 20,000 labourers.

The production process in the factory involves five main work stations crusher, crane, raw mill, kiln cement mill, packing and conveyor belt zone where labourers are employed. The raw material lime stone (>80% calcium carbonate) red soil (>50% silicates) are crushed before entering the raw mill where it is ground to fine particles. The ground material enters the rotary kiln where it is burned at bout 1500-1800°C to form clinker. The clinker is then mixed with controlled quantities of gypsum >60% calcium sulphate) and ground in the cement mill into cement. The finished product is stored in silos then sold in bulk or bagged. Studies done earlier suggests higher concentration of dust will be at cranes (38.6mg/m$^{3)}$, packing 21.3/m$^{3)}$, and crusher (13.5mg/ m^3) and lesser in cement mill (3,26mg/m^3), kiln (2.9 mg/m^3), raw mill (1.8 mg/m^3), maintenance (1.2 mg/m^3), and administration (0.3 mg/m^3).

Study design and methods:

Several prevalence studies have suggested an association between occupational exposure and respiratory symptoms and asthma, but there has been a lack of incidence studies to verify this. This study examined the incidence of respiratory symptoms, asthma and to explore the respiratory morbidity in terms of symptoms in chronic exposed labourers working in cement industry for more than 11 years. All out patients N=18515 (Male: Female=9899:8616 attending Medical College Hospital in Anantapur district, Andhra Pradesh) were considered for the study during the period May 2003 to April 2008. The total strength of the labourers were categorized according to the age (Table 2) which included younger (20-35), middle (36-45) and older (46-55) (Fig. 2). The ages of exposed subjects were comparable (Table 4 and 5). Labourers having respiratory problems like chest pain, dysponea, problems with nose and throat, cold, breathing problema, asthma, productive and non productive cough and wheezing were included for the study. Subjects were considered symptomatic if they reported one or more of the following chronic respiratory symptoms, cough or phlegm production on most days or nights as long as 3 consecutive months referred to as chronic cough/ chronic phlegm. A period of at least 3 weeks during the previous 2 years with increased cough and phlegm were considered as bronchitis, shortness of breathing when walking referred as dysponea, whistling sound in chest on most days or nights as persistent wheeze or attacks of shortness of breath in the previous 2 years as asthma.

Most of the subjects (87%) were with initial chest X-ray. Information on respiratory symptoms, smoking status, age and sex was collected by Dutch version of British Medical Research Council standardized, pretested structure close ended questionnaire. Information was also colleted regarding socio-economic status and working conditions. Other details like use of abuse substance and smoking history were carefully recorded. Later clinical data were analyzed in terms of disordered functions and potential causatives. With regard to socio-economic status, Kuppuswamy's Classification (Park, 1979) were employed for the study. During the investigation the response rate of labourers was nearly 92% at base line and follow up.

Blood samples were taken and eosinophils were counted in a 1:10 dilution using an improved Neaubauer chamber (Superior Germany) expressed in %/cumm. Eosinophils were defined as 4-6%/Cumm in control subjects (Fig. 10).

Statical analysis :

Analysis included all data collected during the survey from 2003 to 2008. Information of two successive surveys was compared to study the development of respiratory symptoms. The paired observation had a minimum interval of 2 years. The incidence of respiratory symptoms was calculated as their percentage of subjects with least symptoms at first of survey who had developed the symptoms at nearest follow-up conducted during the year 2007-08. Blood samples were statistically analyzed by employing student's t- test. Comparison was made between t-calculated value and table value to find significant change in blood cells.

RESULTS AND DISCUSSION

The comparative study on the prevalence of occupational respiratory symptoms age wise in male and female labourers, data were collected based on the history and clinical symptoms. Nearly 70% of males and 30% of females were identified as respiratory suffers to the total surveyed strength of 18515 labourers (Table 3). Most of the labourers were exposed to dust and fumes at an average of 8 hours per day for a period of 11 years.

Respiratory symptoms noticed include dysponea (78.79%), asthma (22.77%) and cough (productive and non-productive) (13.68%) in both sexes. Dysponea (23.50%) was identified as major symptom in males and asthma (28.04%) in females. Middle age group of male labourers (41.65%) and younger age group of female labourers (46%) had recognized the major suffers due to repeated long term exposure (Fig. 5 and 9); prevalence of developing asthma (69%) is more in younger and middle age group of male labourers (Fig. 4 and 5). Current smokers of younger age group were at higher risk of developing chronic bronchitis and wheeze but not asthma. Chronic cough (13.53%) was the common symptom in both sexes exposed to dust and male labourers were at higher risk for developing productive cough and attacks of dysponea. Women were at higher risk for developing wheeze than unexposed. Incidences of respiratory symptom were high in females than men, after adjusting for age and smoking habit (Fig., 7, 8 and 9).

Particulate air pollution has direct implication on respiratory health. Elevated levels of particulate pollution had been associated with increased respiratory morbidity as measured by hospitalization for respiratory diseases (Sunyer *et al.*, 1991) and increased symptoms of

Table 1 : Percentage increase of eosinophils count in exposed labourers

Sr. No	Age group	Mean of control	Mean of exposed	% Change
1.	Younger age male	4.847826	6.108696	20.65
2.	Younger age female	4.759259	7.722222	38.37
3.	Middle age male	5.888889	8.476191	16.98
4.	Middle age female	4.756757	8.72973	45.48
5	Older age male	4.810811	9.324325	45.48
6.	Older age female	4.945946	9.837838	48.41

Table 2 : Distribution of male and females in all three age groups [younger (20-35), middle (36-45), older (46-55)]

	Gender	
	Male	Female
Strength	9899	8616
Percentage	53.46	46.53
	Total 18515	

Table 3 : Strength and percentage of labourers exibiting respiratory symptoms

	Strength	Percentage
Males	6929	70
Females	2585	30
	Total affected: 9514	

Table 4 : Age wise distribution of affected male labourers

Age group	Strength	Percentage affected
20-35	1814	26.18
36-45	2886	41.65
46-55	2229	32.17

Total strength:18515
Total males affected: 9899
Percentage of males affected: 70

Table 5 : Age wise distribution of affected female labourers

Age group	Strength	Percentage affected
20-35	1189	46
36-45	750	29
46-55	646	25

Total strength:18515
Total males affected: 8616
Percentage of males affected: 30

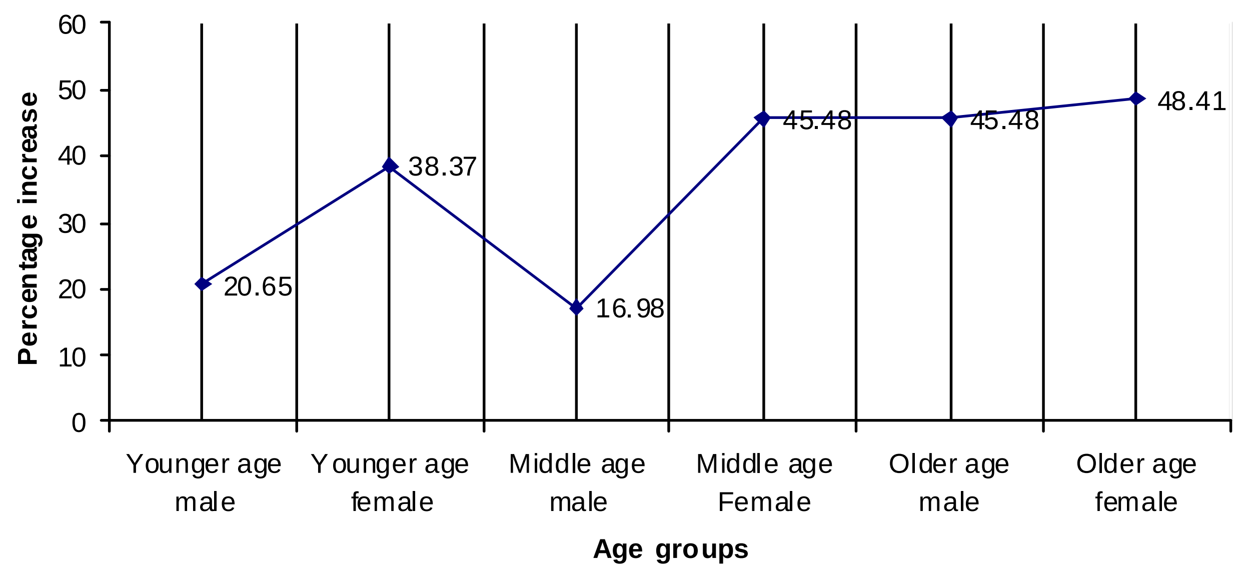

Fig. 1 : Percentage increase in eosinophil count in exposed labourers

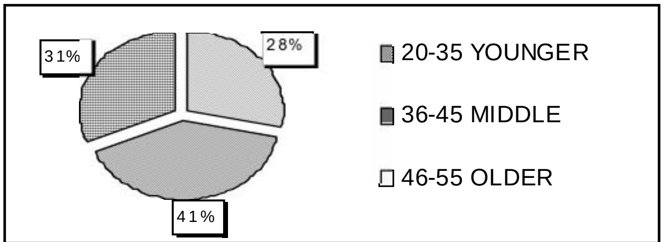

Fig. 2 : Age wise distribution of males in three age groups [younger (20-35), middle (36-45) and older (46-55)]

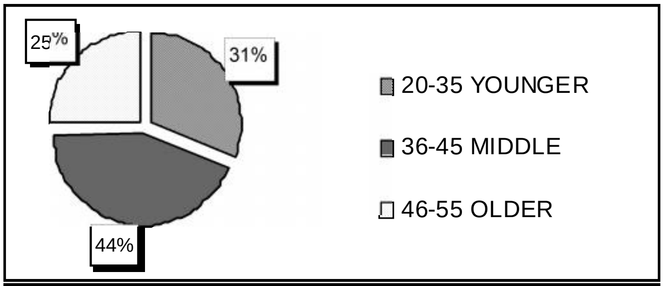

Fig. 3 : Age wise distribution of females in three age groups [younger (20-35), middle (36-45) and older (46-55)]

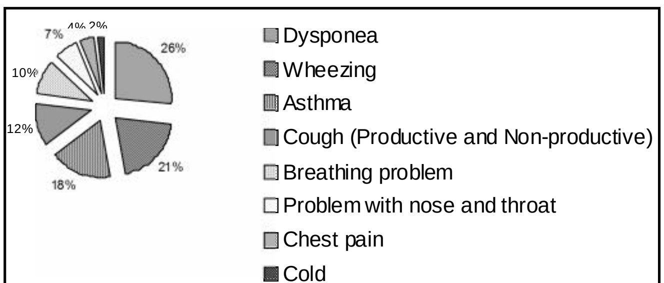

Fig. 4 : Respiratory symptoms exhibited by the younger age group (20-35) in male labourers

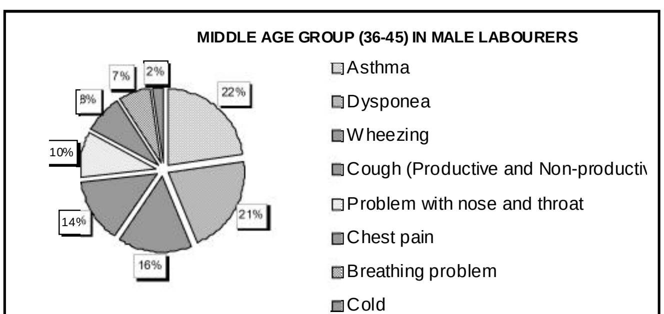

Fig. 5 : Rrespiratory symptoms exhibited by the younger age group (36-45) in male labourers

pulmonary diseases (Schwartz *et al.*, 1991). Long term exposure to particulate pollution and gaseous fumes has been associated with increased risk of developing respiratory morbidity (Archer, 1990).

The major respiratory symptoms noticed during the

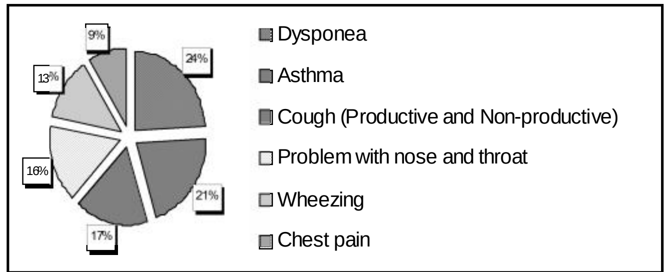

Fig. 6 : Respiratory symptoms exhibited by the younger age group (46-55) in male labourers

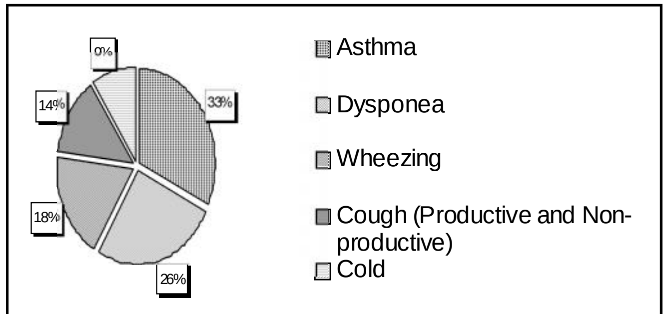

Fig. 7 : Respiratory symptoms exhibited by the younger age group (36-45) in fmale labourers

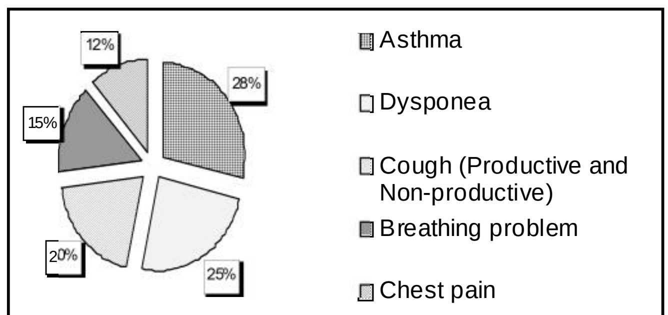

Fig. 8 : Respiratory symptoms exhibited by the younger age group (20-35) in fmale labourers

survey include dysponea (78.79%), asthma (22.77%) and productive and non-productive cough (13.68%). In this study there was an increased risk of developing respiratory symptoms and asthma if exposed to dust or fumes even after adjusting for age, sex, educational level and smoking habits during the follow up. Another subsequent source of particulate matter pollution in the surveyed industrial area included quarrying and mining, which were inherently dusty and high in quartz and mineral dust which contributed the risk for developing respiratory symptoms and asthma. Both mineral dust and quartz exposures were associated with higher risk of the cough symptoms and mineral dust exposure with a higher risk of attacks of dysponea and asthma. The prevalence for developing asthma was more in younger and middle age groups of male labourers as

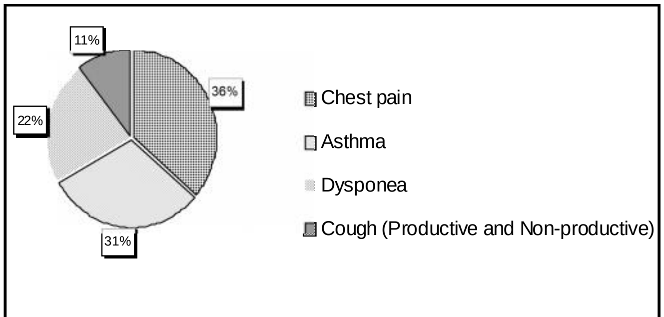

Fig. 9 : Respiratory symptoms exhibited by the younger age group (46-55) in fmale labourers

Viegi and co-workers (1991) reported that the effect of occupational exposure on several respiratory categories including wheezing and asthma was higher among smokers than among non-smokers. Sex differences in the role of smoking in the occurrences of asthma and chronic wheeze has been controversial because of problems of diagnostic bias. In present study data females were more likely to report a doctor's diagnosis of asthma than males and males tended to have more asthma like symptoms without a specific doctor's diagnosis. This is very unfortunate, we have no data that would permit us to determine whether a physician's knowledge of a women's occupation influenced the diagnosis of asthma, chronic bronchitis or emphysema. Exposure is most important determinant in the development of occupational asthma (Viegi *et al.*, 1991). Higher degree of exposure was observed in younger and middle age groups of both males and females, higher was the prevalence of developing asthma in them (Chan-Yeung and Malo, 1995). In sensitized labourers the main factor that influences the on set of symptoms is the degree of exposure (Venables *et al.*, 1990). However, there is lack of information regarding the risk of sensitization at low concentration and existence of no-effect level (Nieuwenhuijsen, 2003). Some studies have shown that intensity of exposure is an important determinant of sensitization and asthma caused

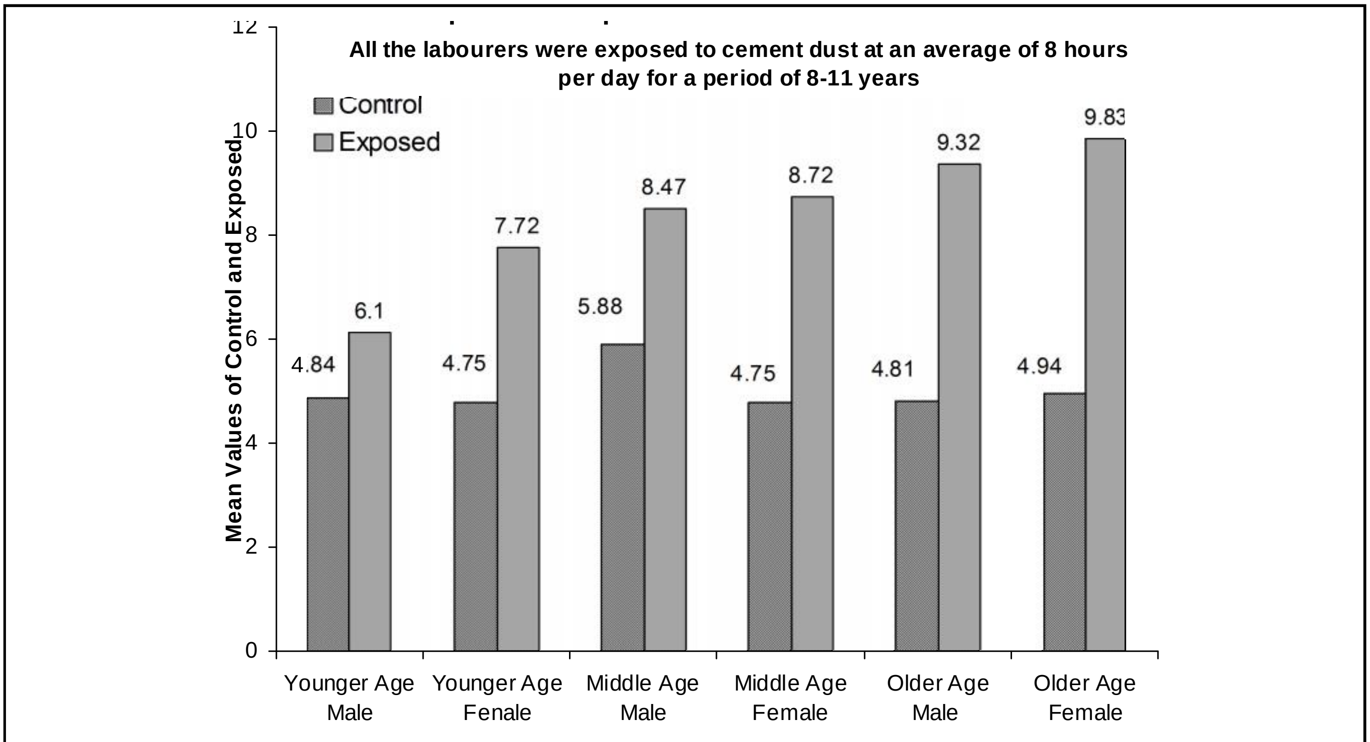

Fig. 10 : Agewise comparision of eosinophils in control and exposed group of male and female labourers

they were much more exposed to dust or fumes prevailing at cranes and packing sections of the industry (Fig. 4 and 5). Majority of the male labourers were smokers (97.14%) and cigarette smoking clearly was associated with asthma and asthma like symptoms. Current smokers of younger age groups were at higher risk of developing chronic bronchitis and wheeze but not of asthma. The present study did not have that much evidence how smoking habit and occupational exposure may interact in relation to the occurrence of asthma and chronic asthma like symptoms. However, it was found that the increased asthmatics due to occupational exposure were mainly present among smokers. Two studies (Korn *et al.*, 1987) have addressed the issue of the combined effect of smoking and occupational exposure on chronic respiratory symptoms.

by respiratory antigens. A review of exposure-response relations for occupational inhaled allergens (Heederik *et al.,* 2001) suggests that there are enough data for assessment of exposure-response relations for several occupational agents (Baur *et al.,* 1998). Concentration of an occupational allergen that sensitizes is quite different from one that provokes symptoms in workers already sensitized (Baur, 2003). Finding of concentration of an occupational agent below which sensitization is uncommon is relevant for prevention. Thus, the minimum concentration that induces sensitization is at least one order, and probably two orders of magnitude greater than the minimum concentration that elicits symptoms. So, the permissible exposure limit (Swanson, 2003) for eliminating sensitization is easier for industry to achieve than the permissible exposure limit for eliminating asthmatic symptoms.

Sex plays a role in the distribution of occupational lung diseases, because there are sex differences in specific jobs and therefore differences in exposure to agents causing these diseases (Occupational Safety and Health Administration 29 CFR 1910.1025. Revised March 1983). Female labourers report significantly more exposure to dust during crushing of stones. In addition, one study reported that the risk of occupational asthma was higher for women (Wai and Tarlo, 2003) especially in loading and packing sections of cement industry (Fig. 7, 8 and 9). A case-control study performed in Toren and co-workers (1991) and Mendonca *et al.* (2003) showed that among women, the risk of adult asthma was increased after exposure to dust and fumes. Whereas among males, the risk of adult asthma was increased after exposure to flour dust, fumes and man-made mineral fibres. Because a strong association has been found between fume and dust related respiratory symptoms suggestive of occupational asthma.

In hyper-responsive subjects, especially in asthmatics there was rise in eosinophils accompanied by wheeze or dysponea whereas in middle and older age groups of male labourers (Table 1) who continued to smoke during the follow up had higher percentage of eosinophils and also had higher risk to develop chronic cough, chronic phlegm, dysponea, wheezing and attacks of bronchitis and doctor diagnosed asthma when compared with never smokers. Dysponea and wheeze appear to occur especially in subjects with both asthma and eosinophilia (Bousquet *et al.,* 1990). Present study showed an increased risk to develop wheeze and dysponea only when eosinophilia and asthma are present.

Chronic cough was the most common symptom in both sexes exposed to dust and among men there was a higher risk for developing productive cough and attacks of dysponea. Among women, there was higher risk for developing wheeze in those exposed to dust compared with unexposed. A Dutch longitudinal community study (El-Zein *et al.,* 2003) observed a higher incidence of chronic non specific lung diseases in those occupationally exposed.

Previous studies on working groups have shown association between mineral dust exposure and air flow limitation (Heederik *et al.,* 1990). In present industrial work area, the most common situation is mixed exposure, samples have shown higher incidences of respiratory symptoms in women than men, after adjusting for age and smoking habits (Hanke *et al.,* 1984). But most prevalence studies have reported no sex differences in the effect of occupational exposure (Xu and Christiani, 1993).

In respiratory diseased labourers, dysponea was commonly associated condition in which respiratory drives are increased or respiratory system is excessively loaded. In affected middle age group of male labourers and younger age group of female labourers (Fig. 5, 6 and 7) it is characterized by perception of "air hunger" or increased effort of breathing. It was identified in labourers with airflow obstruction like bronchial asthma; chronic pulmonary diseases dysponea was commonly associated. The impact of pulmonary hazards is also influenced by air pollution in general; age, smoking history, nutritional status, and other less well understood factors such as genetics and stress. Many work processes generate several contaminants at the same time. The health consequence of these hazards can simply be additive or, worse, they can be synergistic.

In conclusion this case study shows that repeated, long term occupational airborne exposure in labourers of cement industry, increases the risk for developing respiratory symptoms and asthma. This effect is independent of sex, age and educational level. Smoking and occupational dust exposure act synergistically and can increase both severity of an occupational lung diseases and risk of developing respiratory symptoms.

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