**LITERATURE REVIEW**

The main purpose of the chapter is to present a resume of conceptual frame work relating to ascertain the association between occupational exposure to silica dust and Chronic obstructive pulmonary disease (COPD) among the stone quarry workers of Sylhet. Past studies give way to future research endeavor. An acquaintance with earlier pertinent studies was felt necessary for better understanding of the research problem and to develop appropriate research methodology. The relevant studies and their findings are limited, which are related to Sylhet region. However, an attempt is made to orient much on the theoretical views of different authors/scientists on the subject and closely related results are reported. Keeping in view the subject of the study, the review of the available literature related to the study are presented under the following discussion.

**AN OVERVIEW OF COPD**

COPD is a name coined for the diseases that were previously known as chronic bronchitis and emphysema. The American Thoracic Society (ATS) defines COPD as a “disease state characterized by the presence of airflow obstruction due to chronic bronchitis or emphysema” (Celli et al., 1995).

The British Medical Research Council (BMRC) defined chronic bronchitis as “daily productive cough for at least three consecutive months for more than two successive years (“Definition and classification of chronic bronchitis for clinical and epidemiological purposes. A report to the Medical Research Council by their Committee on the Aetiology of Chronic Bronchitis.,” 1965). Chronic bronchitis, with an obstructive ventilatory pattern that is defined by the existence of chronic bronchitis with permanent obstruction of airways (forced expiratory volume in 1 s (FEV1) to forced vital capacity (FVC) ratio <70%) (Raherison & Girodet, 2009).

American Thoracic Society (ATS) in 1962 defined emphysema as an “anatomic alteration of the lung characterized by an abnormal enlargement of the air spaces distal to the terminal, non-respiratory bronchiole, accompanied by destructive changes of the alveolar walls” (Fletcher & Pride, 1984). Centrilobular emphysema is a result of the dilation or destruction of respiratory bronchioles. It is a form of emphysema associated with cigarette smoking. Pan lobular emphysema is more often associated with a deficit in α1-antitrypsin, and is the result of dilation or destruction of all the lobules. It should be noted that centrilobular and pan lobular emphysema can be mutually associated (Raherison & Girodet, 2009).

Reid reported that “the diagnosis of emphysema by itself is incomplete unless it is taken into account the presence or absence of chronic bronchitis and vice versa” (L. Reid, 1967). McDonough et al have recently reported extensive obliteration of terminal bronchioles in patients with COPD who have emphysema, suggesting that “the permanent enlargement of the distal airspaces may serve only as a structural biomarker, being a secondary result of small airway inflammation and destruction” (Mitzner, 2011).

The Global Initiative for Chronic Obstructive Lung Disease (GOLD) recently defined COPD, a common preventable and treatable disease, is characterized by persistent airflow limitation that is usually progressive and that is caused by an enhanced chronic inflammatory response in the airways and the lung to noxious particles or gases ((NIH), (NHLBI), & (WHO), 2008).

**INCIDENCE AND PREVALENCE OF COPD**

COPD is a slowly progressive, potentially highly disabling, respiratory condition with many potential causes. A better understanding of these causes paves the way for effective interventions to reduce the future incidence of this unpleasant condition (Fishwick, Barber, & Darby, 2010).

***World Scenario***

COPD is increasing worldwide, in both developed and developing countries (Govender, Lalloo, & Naidoo, 2011). According to estimates from the Global Burden of Disease Study, COPD was prevalent in more than 300 million people in 2013 (Vos et al., 2015). A. D. Lopez et al., (2006) have recently reported that COPD is a major cause of morbidity and mortality worldwide and results in an economic and social burden that is both substantial and increasing.

The overall COPD prevalence among US adults aged 40–79 years varied from 0.2% to 20.9% based on whether pre- or post-bronchodilator values were used and which diagnostic criterion was applied (Tilert, Dillon, Paulose-Ram, Hnizdo, & Doney, 2013). The overall prevalence of COPD in the Netherlands is 3.0% (Afonso, Verhamme, Sturkenboom, & Brusselle, 2011). In Denmark, the overall prevalence of COPD is 17.4% (Fabricius, Løkke, Marott, Vestbo, & Lange, 2011).

In European adult populations over 40 years, the prevalence of COPD ranges between 15–20% and is higher in men than in women (Atsou, Chouaid, & Hejblum, 2011). In Spain, the COPD prevalence is 7.3% as found by Cabrera López et al., (2014) and 10% as found by Gómez Sáenz et al., (2014). Cazzola et al., (2011) conducted a research based on national medical in Italy, reported that, COPD prevalence at 2.8%.

COPD prevalence among adults aged 40–80 years in Abu Dhabi was reported at 3.7% (Al Zaabi et al., 2011). According to Tageldin et al., (2012) COPD prevalence in the Middle East and North Africa is 3.6%. The pooled COPD prevalence defined by GOLD criteria at Latin America and the Caribbean is 13.4% (Ciapponi et al., 2014). A Meta-analysis of five spirometry-based studies from Africa reported a mean prevalence of COPD as 13.4%, ranging from 9.4 to 22.1% (Adeloye et al., 2015). Another Meta-analysis of nine studies from Sub-Saharan Africa reported a prevalence ranging from 4 to 25% (Finney, Feary, Leonardi-Bee, Gordon, & Mortimer, 2013). In 2012, a study done in rural Uganda reported a COPD prevalence of 16.2% in people older than age 30 years. Higher prevalence among people aged 30–39 years was reported in this study which is made by Van Gemert et al., (2015).

The reported prevalence of COPD ranged from 0.2% in Japan to 37% in the USA, but this varied widely across countries and populations both by the diagnosis method and by the age group analyzed (Rycroft, Heyes, Lanza, & Becker, 2012). Moreover, the assessment of prevalence rates may change considerably according to the diagnostic tools also (Viegi, Maio, Pistelli, Baldacci, & Carrozzi, 2006).

Generally, NMRD combines deaths from pneumoconiosis and COPD. In mortality studies of South African gold miners, deaths from pneumoconiosis (ICD9, 500–505) and COPD (ICD9, 416, 490–492, 496) were coded separately, based on death certificate and postmortem examination findings for pneumoconiosis, emphysema, and airways disease. In a recent study, of total 2032 deaths, 138 were from COPD (SMR 161, 95% CI 135 to 190), and 16 were from pneumoconiosis (P. J. Reid & Sluis-Cremer, 1996).

***Bangladesh Scenario***

According to the 2001 World Bank/WHO Global Burden of Disease report, COPD is the sixth leading cause of death in developing countries, responsible for 4.9% of deaths. Now, this is the third leading cause of death (Alan D. Lopez, Mathers, Ezzati, Jamison, & Murray, 2006). Peter J. Barnes, (2012) claimed that more than 90% of COPD deaths occur in low and middle-income countries.

In Bangladesh, limited data are available on COPD. Since 2000, several studies have been conducted in Bangladesh to identify the burden and risk factors of COPD. Sutradhar et al 2019 conducted his study in terms of methodology (hospital-based and population-based study), sample size, and area of the study (urban/rural). Furthermore, different criteria were used to measure the COPD status in these studies. However, no systematic review has been carried out in Bangladesh to provide a clear scenario of COPD burden and risk factors in this country. Therefore, they carried out this systematic review with the aim to find out the prevalence of COPD and its associated risk factors among the Bangladeshi population (Sutradhar, Das Gupta, Hasan, Wazib, & Sarker, 2019).

Rabe et al., (2007) found result in Bangladesh that, age-adjusted death/100000 is 66.4. A large cluster study, [Burden of Obstructive Lung Disease (BOLD)] found that the population prevalence of COPD among people greater than 40 years and older is 21.6% and overall prevalence in general population is 4.32%. The disease hits hardest those who are still in the productive phase of life (42% of COPD between 40 and 50 years) (R. R. Biswas & Chowdhury, 2017). According to high-quality studies that used the GOLD criteria, the pooled COPD prevalence among Bangladeshi adults was 12.5% (95% CI, 10.9-14.1) ranging between 11.4% (95% CI, 9.3-13.5), which was found among participants aged 35 years or more, and 13.5% (95% CI, 12.4–14.6), which was reported among participants aged 40 years or above (Alam, Chowdhury, Siddiquee, Ahmed, & Clemens, 2015).

However, according to Afonso et al., (2011), using the lower limit of the normality (LLN) criteria, pooled COPD prevalence was 11.9% (95% CI, 11.4-13.6) ranging from 10.0% (95% CI, 8.6-11.4) in urban Dhaka to 15.4% (95% CI, 14.2-15.8) in rural Matlab.

Two moderate-quality studies were carried out on two specific groups of population: (a) R. S. R. Biswas et al., (2016) conducted a study on women of rural Chittagong exposed to fuel smoke and (b) helpers of human haulers of Dhaka city (Mahfuz, Ahmed, Ahmad, & Khan, 2014). Remarkably, the prevalence of COPD was found much higher in these two groups of people (women exposed to fuel smoke: 20.4%; helpers of human haulers: 41.7%).

According to the high-quality studies, the prevalence of COPD was greater among males and ranged from 11.7% to 22.0% compared to females (range: 6.4% to 10.6%). These two studies also reported that COPD was more prevalent among the low socio-economic groups (13.6% to 16.3%) than the high socio-economic groups (9.8% to 11.1%). Interestingly, Alam et al., (2015) found that the mean age of COPD patients was higher than that of the non-COPD patients (COPD: 57 years; non-COPD: 44 years). A high-quality study conducted by Islam et al., (2013) reported that COPD was more prevalent among rural people (17.0%) than their urban counterparts (9.9%).

The pooled prevalence of COPD among people in the 40-49 years age group was 7.5% (range: 5.2% to 9.8%). On the other hand, this prevalence was 21.5% (range: 13.6% to 29.4%) among 50-59 years age group and 39.3% (27.5% to 51.0%) among people of 60-69 years age group (Alam et al., 2015; R. S. R. Biswas et al., 2016). Islam et al., (2013) reported that the prevalence of COPD was also higher among biomass fuel users and ranged from 16.4% to 17.3% compared to clean fuel (e.g. LP gas or natural gas) users (range: 4.4% to 10.0%). Based on peak expiratory flow rate (PEFR)%, severe bronchial obstruction was also found higher among biomass fuel users (55.4 %) than gas users (29.1%) (Alim et al., 2014).

According to a study known as BOLD-BD (Burden of obstructed lung disease in Bangladesh), on COPD conducted by Bangladesh lung foundation, Burden of COPD in Bangladeshis are as follows:

* Prevalence in >40 years of age is 21.24%
* Prevalence in general population is 4.3%
* Total burden of COPD patients is about 6 million.

**CAUSES/RISK FACTORS OF COPD**

By reviewing many study De Marco et al., (2011) concluded that, tobacco smoking is the main cause of COPD and it is also the main determinant of a poor outcome in those who have the disease. Other factors may influence the risk of developing COPD. The host factors that seem to play a major role are age, a previous history of asthma, genes, and early respiratory infections. Among environmental determinants, occupational exposures and exposure to biomass smoke are primary risk factors. The role of sex, socioeconomic status, and body mass index (BMI) on the risk of developing COPD is still open to debate. According to these authors, cigarette smoke is the most important risk factor for COPD also among young adults, and that smoking prevention could reduce the incidence of COPD in the young population by 29 to 39%. They also showed that well-known risk factors for asthma, such as AHR, familiarity, and respiratory infection in childhood, are relevant risk factors also for COPD. The proportion of new cases of COPD due to each of these factors ranges from 8% (respiratory infections) to 15% (AHR). Their longitudinal study points out that subjects with BMI less than 18.5 kg/m2 had a threefold risk of developing the disease compared with subjects with a normal weight. However, the association was weaker when LLN diagnostic criteria they were used.

While tobacco smoking is a major risk factor for COPD, only approximately 20% of smokers develop the disease. More evidence is rising to suggest that other risk factors such as air pollution, respiratory infections, poor nutritional status, chronic asthma, impaired lung growth, poor socio-economic status and genetic factors are also important for disease development (S. S. Salvi & Barnes, 2009). According to the last updates of the Global Initiative for Chronic Obstructive Lung Disease (GOLD), occupational exposure is one of the two most important risk factors for COPD (Gerald & Bailey, 2002)

***Exposure to tobacco smoke/Smoking and Secondhand Smoke***

Eva Hnizdo et al., (2002) conducted a study on US workers and found that >10 000 adults concluded that COPD attributable to work was 19% in the total population, and 31.1% among never smokers. They also added the sex-specific analyses and showed that for females, the adjusted odds ratios for COPD (number of cases/number of subjects exposed) were increased for rubber, plastics, and leather manufacturing overall (8/46; OR = 4.7, 95 percent confidence interval (CI): 2.7, 8.3) and for never smokers in that industry (2/31; OR = 3.8, 95 percent CI: 1.2, 12.3); for the textile mill products manufacturing industry overall (10/99; OR = 2.4, 95 percent CI: 1.2, 4.8) and for never smokers in that industry (3/53; OR = 6.0, 95 percent CI: 0.6, 62); for the agriculture industry overall (13/196; OR = 2.0, 95 percent CI: 0.9, 4.5) and for never smokers in that industry (6/134; OR = 2.3, 95 percent CI: 0.5, 10.4); for sales overall (40/512; OR = 1.6, 95 percent CI: 0.9, 2.9) and for never smokers in that industry (8/279; OR = 3.0, 95 percent CI: 0.7, 13); for food products manufacturing overall (9/123; OR = 1.5, 95 percent CI: 0.6, 4.0) and for never smokers in that industry (2/77; OR = 3.4, 95 percent CI: 0.3, 44); and for personal services overall (34/470; OR = 1.5, 95 percent CI: 0.7, 3.2).

Chronic tobacco smoking is the major risk factor for the development of COPD, but only a relatively small proportion of smokers actually develop airway obstruction. Although there is a dose-response relationship between FEV1 and the extent of cigarette smoking, smoking history accounts for only approximately 15% of the variation in lung function. That is why the genetic predisposition of COPD may exist in smokers. Although cigarette smoking is the most important risk factor for the development of COPD, allergic airway inflammation, long-standing asthma, air pollutants, and diesel exhaust particles may also cause irreversible airflow limitation such as COPD. Environmental pollution, age, and airway hyperreactivity are also the risk factors.

Whilst cigarette smoking is widely recognized as the most important cause, the specific relationship between COPD and the workplace is important, and the perception of this relationship will depend on the experience of each individual health care worker and on the nature of their previous contact with COPD patients and workplaces. This relationship is now better understood, although there is considerable scope for further research (Fishwick et al., 2010).

Menezes et al., (2005) reported that, there was a consistent pattern of higher prevalence in men, in older people, and in those with less education, lower body-mass index, and greater exposure to smoking. Among risk factors, tobacco smoking either active or passive, current or ex-smoking-all have a higher respiratory symptoms and lung function abnormalities, a greater annual rate of decline in FEV1 and a greater COPD mortality rate than nonsmokers.

Although prevalence varies across countries, in Bangladesh, it appreciably higher in smokers and ex-smokers compared with non-smokers, in those older than 40 years compared with those younger than 40 years and in men compared with women. Tobacco consumption, in the form of smoking or chewing, was found associated with an increased prevalence of COPD in four studies (Alam et al., 2015; R. S. R. Biswas et al., 2016; Islam et al., 2013; Mahfuz et al., 2014).

Alam et al., (2015) reported that both current smokers (OR: 5.5; 95% CI, 4.2-7.2; p < 0.001) and former smokers (OR: 4.5; 95% CI, 3.3-6.0; p < 0.001) were at a higher risk to experience COPD after adjusting potential confounders. He also made conclusion that, prevalence was three times higher in males compared to females (22% VS 6.4% by GOLD criteria and 16.2% VS 5.3% by LLN criteria) and about 60% higher in rural than urban populations (17% VS 9.9% by GOLD criteria and 12.5% VS 8% by LLN criteria). COPD was higher among individuals from households using biomass fuel compared to clean fuel (natural gas) users (17.3% VS 9.9% by GOLD criteria and 12.7% VS 7.9% by LLN criteria). Th e prevalence of stage I (mild), stage II (moderate), stage III (severe), and stage IV (very severe) COPD was 2.7, 8, 2.3, and 0.6%, and by the GOLD severity criteria and 1.2, 6.4, 2.2 and 0.5% by the LLN criteria. Increase in GOLD-defined COPD relative to the LLN largely occurred in those aged 60–69 years.

Biswas et al., (2016) conducted a study with rural women and found that, (>40 years old) having tobacco chewing habit were 13 times more likely to suffer from COPD (OR: 12.9; 95% CI, 3.4-49.4; p < 0.001). Among the 250 females, 150 (60%) were biomass fuel users and Natural gas/LPG users were 100 (40%). COPD was found in 41 (16.4%) biomass users and 10 (4%) in later. The frequency of COPD was 20.4% with a higher number in women who were using biomass then who were using natural gas/LPG (p<0.001). Regarding risk analysis, biomass fuel was found significantly associated with COPD (OR= 3.385, CI=1.606-7.135, p<0.05). Multinomial logistic regression analysis showed respiratory distress in family members (OR0.63) nature of kitchen (1.20) seasonal variation in cooking (OR-1.24), cough in childhood (OR-0.33) tobacco chewing habit (OR-12.49) type of stove (OR-0.19) history of cough (OR-0.13) and life time smoking history (OR-0.37) risk factors. Lung function also was significantly reduced (p<0.05) among women using biomass.

***Exposure to fumes from burning fuel/Air pollution***

Biomass smoke is one of the major air pollutants and contributors of household air pollution worldwide. It is considered one of the leading environmental risk factors of several diseases, including COPD and acute lower respiratory disease, and is thought to cause 4 million deaths annually across the globe (Capistrano, van Reyk, Chen, & Oliver, 2017). Wood smoke and other biomass exposure have been shown to be independent risk factors for obstructive airways disease, and earlier and longer time of exposure has been shown to increase the risk for development of COPD (S. Salvi & Barnes, 2010). According to Ocakli et al., (2018), the combustion of biomass fuels has now been recognized as a relevant risk factor for respiratory disorders, such as chronic bronchitis and COPD, asthma, lung cancer, lung fibrosis, and tuberculosis.

Biomass smoke exposure is a prominent risk factor for developing several airway diseases. For example, relative to non-exposed people, those exposure to biomass smoke have an odds ratio of 2.44 (95% CI, 1.9–3.33) for developing COPD (Hu et al., 2010). While among women over 30 who were predominantly undertaking domestic duties in rural areas the relative risk for COPD was estimated as either 3.2 (95% CI 2.3–4.8) (Ezzati, Lopez, Rodgers, & Murray, 2004) or 2.14 (95% CI 1.78–2.58) (Balmes, 2010).

A systematic review and meta-analysis identified 23 studies, 10 reporting COPD based on both physician diagnosis and spirometry definitions, 11 reporting chronic bronchitis based on respiratory questionnaire data, and two reporting both COPD and chronic bronchitis. The pooled effect estimates for lung function diagnosed COPD (OR 2.96, 95% CI 2.01–4.37) was greater than those diagnosed by a doctor in hospital (OR 2.29, 95% CI 0.70–7.52), with a combined pooled effect estimate of 2.80 (95% CI 1.85–4.23) for COPD. Similarly, the pooled effect estimates for chronic bronchitis was 2.32 (95% CI 1.92–2.80) of chronic obstructive pulmonary disease (COPD) in populations exposed to solid fuel smoke (Kurmi, Semple, Simkhada, Cairns S Smith, & Ayres, 2010).

The odds of having biomass fuel smoke exposure among males were 4.25 while in the female it was 4.37. Overall OR is 3.16. The odds of having other types of indoor pollution such as wood exposure, coal and stove exposure in COPD patients are 2.70, 2.45, and 2.05, respectively, in comparison to the control group. Among the above exposures, biomass fuel smoke, wood smoke exposure, and coal smoking were statistically significant with value of P = 0.0001, 0.003, and 0.02, respectively (Madhurmay et al., 2019).

Hu et al., (2010) conducted a meta-analysis with 15 epidemiologic studies covering a wide range of countries and found that people exposed to biomass smoke had combined odds ratio (OR) of 2.44 for developing COPD as assessed by lung function measurements or symptom-diagnosed chronic bronchitis, and that this was true for both women and men. Moreover, cigarette smoking appeared to have a synergistic effect with biomass smoke, increasing the OR for COPD development to 4.39.

In Bangladesh, many studies found significant association was reported with the development of COPD and the use of biomass fuel for cooking purpose in three studies (Alam et al., 2015; Alim et al., 2014; R. S. R. Biswas et al., 2016). Two moderate-quality studies found that biomass fuel use was positively associated with a higher prevalence of COPD among rural women (Alim et al., 2014; R. S. R. Biswas et al., 2016). The women in rural areas suffer more from COPD than those in urban areas. According to that study, exposure to biomass smoke (from open stoves/wood fires) appears to be a significant risk factor for the disease in village women.

Alam et al., (2015) studied with nearly 4,000 urban and rural participants also found that biomass fuel users were six times more likely to have COPD compared to clean fuel users (OR: 5.9; 95% CI, 1.0-34.5; p = 0.047).

***Cause of airflow obstruction in silica dust exposed workers***

In summary, deaths from COPD likely constitute a large proportion of deaths from NMRD in silica dust exposed workers. Silica dust exposure increases mortality from COPD and the effect is modified by tobacco smoking. Evidence to help assess cause(s) of COPD in an established case is generally lacking (for example the relative contributions of smoking, coal dust exposure and family history of COPD in a retired coal miner). Whilst results from studies discussed later in this article are broadly useful in advising patients about the general harm caused by dusty occupations, the results do not normally translate sufficiently well to help inform individual cases. This is probably because most previous studies have been designed to assess the respiratory harm caused by individual workplaces with known exposures, or to measure excesses of COPD in certain population groups. Numerous mortality studies of cohorts of silica dust exposed workers report increased mortality from non-malignant respiratory disease (Steenland & Brown, 1995).

Epidemiological and clinicopathological studies investigated whether silicosis or other silica dust associated pathological changes cause airflow obstruction in silica dust exposed workers. Two case-control studies compared lung function in South African gold miners with and without radiological signs of silicosis, who were matched for cumulative dust exposure, tobacco consumption, and age. No significant differences were found between silicosis and non-silicosis miners in spirometry (Irwig & Rocks, 1978).

Epidemiological studies show that silica dust exposure can lead to airflow obstruction in the absence of radiological signs of silicosis (Meijer, Kromhout, & Heederik, 2001) and that the association between cumulative silica dust exposure and airflow obstruction can be independent of silicosis (Irwig & Rocks, 1978). About 15–20% of COPD cases are due to occupational exposures to pollutants at the workplace (Gibson, Loddenkemper, Lundbäck, & Sibille, 2013).

***Occupational exposure to silica dusts and chemicals***

Occupational exposures such as to vapors, gases, dusts and fumes present an important risk factor for the development of the disease, by itself and through interaction with other risk factors (Eva Hnizdo et al., 2002). The epidemiological evidence supporting the role of occupational exposures (organic and inorganic dusts, metal fumes, chemical vapors) as risk factors has been published in population-based studies, and also studies regarding working environments with specific exposures (P. D. Blanc et al., 2009).

Occupational exposure to crystalline silica (silica) dust occurs in many industrial operations worldwide (“Adverse effects of crystalline silica exposure. American Thoracic Society Committee of the Scientific Assembly on Environmental and Occupational Health.,” 1997). The reduction of silica dust exposure levels in most developed countries during the last century resulted in dramatic decreases in morbidity and mortality from silicosis and silica dust associated tuberculosis (TB). Despite this, chronic obstructive pulmonary disease (COPD) remains a health issue in workers exposed to silica dust (E. Hnizdo & Vallyathan, 2003).

It is therefore likely that certain properties of silica dust are capable of causing COPD that may precede, or be independent of, silicosis development. Recent clinicopathological and experimental studies help to explain the potential for silica dust to cause pathological changes that may lead to the development of COPD (E. Hnizdo & Vallyathan, 2003).

It is more difficult to estimate the specific contribution of occupational exposures because of the strong causal association with tobacco smoking and the late onset, often after retirement age. Nevertheless, about 15% of all COPD cases in Western societies have been attributed to exposure to vapours, gas, dust or fumes, mainly based on past occupational studies in the highly exposed mining, textile and farming sectors (Paul D. Blanc, 2012). Since the seminal paper on chronic airflow limitation and occupational exposures by Margaret Becklake in 1989, the evidence for work-related COPD has grown substantially (Becklake, 1989).

Recent large population-based epidemiological studies that have been able to control for smoking and other potential confounding factors, such as asthma, have found occupations at increased COPD risk even at lower community exposure levels (De Matteis et al., 2016). In addition, the American Thoracic Society’s consensus statement suggests that between 10% and 20% of COPD is attributable to workplace exposures (“American thoracic society statement: Occupational contribution to the burden of airway disease,” 2003).

***Combined effect of occupational exposure, smoking and asthma on airflow obstruction***

Work may have an interactive effect with tobacco smoke, resulting in greater severity of disease with greater disability or by accelerating the rate of loss of lung function among those with the disease (Harber et al., 2007). It is well known that tobacco smoke and occupational exposures exert a synergistic effect and increase each other′s influence (Ameille, Dalphin, Descatha, & Pairon, 2006).

Several studies have shown that smoking can potentiate the effect of silica dust. Studies of Canadian and US hard rock miners found that the effect of silica dust on lung function pattern is different in smokers compared to non-smokers (Manfreda, Sidwall, Maini, West, & Cherniack, 1982).

Mazitova et al., (2012) explained odds ratios for different types of occupational noxious particles and gases among COPD patients were highest for silica dust (OR=6.2; 95 % CI=3.6 to 10.7; p<0.0001). Occupational risk assessment calculated separately for nonsmoking and smoking workers showed that the odds ratios for occupational COPD were significantly higher for nonsmokers. For the smoking workers, smoking was a major risk factor for COPD development (Table 3). Thus, the odds ratio for occupational COPD for non-smokers was almost seven times higher than that of smokers and their attributable risk for occupational COPD was more than 95 % compared to 65 % for smokers.

Thus, after matching on cumulative silica dust exposure and smoking, radiological signs of silicosis were not associated with significant airflow obstruction. These results support the hypothesis that the effect of cumulative silica dust exposure on airflow obstruction seen in the cohort of South African gold miners is independent of silicosis (Wiles & Faure, 1975).

E. Hnizdo et al., (1990) conducted a study on South African gold miners estimated the fraction of cases with severe airflow obstruction attributable to dust only, smoking only, and the combined effect of the two exposures (that is, the attributable fractions), and the fraction of cases that could be prevented by removal from each exposure. The attributable fractions for severe airflow obstruction (found in 20% of miners) were estimated as 8% for dust alone, 42% for smoking, 40% for the combined effect of silica dust and smoking, and 10% for unknown factors. Estimated preventable fractions show that elimination of silica dust exposure would prevent 48%, and elimination of smoking 82% of severe airflow obstruction. Despite smoking being the most important risk factor for this disease, accounting for >75% of cases of disease, occupational exposures, alone or in combination with smoking, are responsible for a substantial proportion of disease (Eisner et al., 2010).

The studies found increasing exposure-response trend for COPD mortality and cumulative dust exposure that was modified by tobacco smoking. The attributable fractions for COPD mortality were estimated as 5% for dust alone, 34% for smoking, 59% for the combined effect of silica dust and smoking, and 2% for unknown factors. In the absence of silica dust exposure, 64% of COPD deaths could be prevented, whereas in the absence of smoking, 93% of COPD deaths could be prevented (E. Hnizdo et al., 1990).

The definition of asthma includes bronchial hyperresponsiveness, airway inflammation, and the presence of airflow obstruction, which may be relieved spontaneously or with medication (Nhlbi, 1991). COPD, however, is defined as a chronic and usually progressive disease characterized by airflow limitation that is not fully reversible (Gerald & Bailey, 2002). Whereas asthma is most frequently diagnosed during childhood and is associated with atopy and eosinophilic inflammation, COPD is usually diagnosed during the middle or later life and is associated with neutrophilic inflammation (P J Barnes, 2000). Despite distinctive clinical physiologic features at the time of initial diagnosis, epidemiologic studies of asthma and COPD have shown that the two diseases over time may develop physiologic features that are quite similar. The rapid rate of decline in pulmonary function, characteristic of subjects with COPD, may be seen in asthmatic subjects as well (P J Barnes, 2000).

There is sufficient evidence of an association between chronic asthma and both chronic airway obstruction and accelerated loss of pulmonary function. Because airway obstruction can lead directly to COPD, it is likely that asthma, with or without additional risk factors, can predispose a person to develop COPD. Studies demonstrating radiographic evidence of emphysema among life-long nonsmokers with asthma also support the possible role of chronic asthma in the genesis of COPD. It remains uncertain, however, whether adults with asthma who meet spirometry criteria for COPD, such as the GOLD criteria, are phenotypically and pathologically similar to or distinct from ‘‘typical’’ COPD as it is usually encountered in clinical practice.

One study showed that adults with asthma and fixed airway obstruction differ from those with COPD in radiographic appearance (lower HRCT emphysema scores) and airway inflammation (more eosinophils and fewer neutrophils) (Fabbri et al., 2003), although other investigators have found airway neutrophilia in severe asthma that is more similar to COPD (Wenzel et al., 1999, 1997). Further research will be necessary to define sub phenotypes of COPD and the relationship to chronic asthma and airway remodeling (Eisner et al., 2010).

Furthermore, it has been reported that occupational exposures, such as to vapors, gas, dust or fumes, might trigger COPD exacerbations in a similar way to that in which they elicit asthma attacks (Paulin et al., 2015). Paulin et al., 2015 conducted a multicenter cohort study including current and former smokers with and without COPD, Participants with COPD were 40 to 80 years old. In that study, association between occupational exposure with COPD, it was not statistically significant (odds ratio [OR], 1.20; 95% confidence interval [CI], 0.92–1.56) in bivariate analysis; however, after adjustment for potential confounders, including smoking, occupational exposure was associated with a higher point-estimated odds of COPD, which was statistically significant (OR, 1.44; 95% CI, 1.04–1.97). Occupational exposures were associated with greater odds of COPD among former smokers as compared with current smokers (OR, 1.75; 95% CI, 1.15–2.66 vs. OR, 1.09; 95% CI, 0.66–1.82; smoking- exposure interaction, P =0.06) and among those with fewer versus more pack-years of smoking (OR, 1.97; 95% CI, 1.27–3.05 vs. OR, 1.02; 95% CI, 0.64–1.61; pack-years–exposure interaction, P =0.05). There was no substantive difference between male and female smokers and the odds of COPD (men: OR, 1.44;95% CI, 0.95–2.17 vs. women: OR, 1.41; 95% CI, 0.85–2.31; sex–exposure interaction, P =0.74). When defining COPD using LLN criteria (n = 595), there was an association between occupational exposures and COPD in bivariate (OR,1.44; 95% CI, 1.12–1.85) and multivariate (OR = 1.57; 95% CI, 1.18–2.10) analyses.

In Bangladesh, Alam et al., (2015)reported that individuals with a history of asthma had seven times higher probability of developing COPD, even after adjusting for smoking history and other potential confounders (OR: 6.9; 95% CI, 4.9-9.5; p < 0.001).

In summary, the evidence shows that smoking potentiates the effect of silica dust exposure on airflow obstruction. Thus, eliminating or decreasing both dust and smoking, occupational exposure, asthma are some important which associated with COPD.

***Association of COPD and Socioeconomic status/ Demographic profile***

Many studies from developed countries suggested that socioeconomic status (SES), measured by income and educational level, is associated with lung function and COPD in terms of exacerbation, prevalence and mortality. This association may be partly explained by the greater proportion of smokers among people in lower socioeconomic groups, but smoking may not explain all of the association.

Yin et al., (2011) conducted a study to clarify the association between COPD and socioeconomic status. They include 51,520 subjects sampled from 31 provinces, autonomous regions and municipalities, 49,363 subjects with complete data were included in the analysis in that report. The overall crude prevalence of COPD was 2.9% (95%CI 2.8-3.1) based on self-report. Standardized to world standard population 2000, the prevalence rate of COPD was 2.2% (95%CI 2.1-2.4%). Among 1423 subjects with COPD, 53.1% were never smokers. The prevalence among men was significantly higher than among women (3.4% vs. 2.4%, p < 0.001), rural area higher than urban area (3.1% vs. 2.5%, p < 0.001), and western areas (3.7%) higher than central (2.7%) and eastern (2.2%) areas (table 2). The prevalence increased with age, from 0.8% in the youngest age group (15-29 years) to 7.5% in the eldest age group (60-69 years). Former smokers had a higher prevalence of COPD (9.0%) compared to current smokers (3.3%) and never smokers (2.3%). Those with educational level < 9 years had a higher COPD prevalence than subjects with educational level ≥ 12 years (4.2% vs. 1.6%, p < 0.001). Similarly, subjects with low household income had a higher prevalence of COPD compared with those with high household income (4.1% vs. 2.2%, p < 0.001). Educational level and household income were associated with significantly higher prevalence of COPD in both urban and rural areas. As shown in table 3, after adjusting for age, sex, smoking status, passive smoking and geographic regions, the odds for those with < 9 years educational level were 1.67 (1.32-2.13) in urban and 1.76 (1.34-2.30) in rural areas compared with subjects with education ≥ 12 years. The trend was significant in crude and adjusted model. Compared to subjects with high household income, those with low household income had a higher risk of COPD prevalence (OR 1.64, 95%CI 1.28-2.09) in urban areas. Low household income was associated with high COPD prevalence in rural areas in crude analysis, but not after adjustment for potential confounders (p for trend = 0.466). When stratified by smoking status, there was still a significant association between educational level and prevalence of COPD in both smokers (OR 1.64, 95%CI 1.26-2.12) and never smokers (OR 1.77, 95%CI 1.40-2.25), suggesting that educational level is a risk factor for COPD independent of smoking. The association between household income and COPD was observed in never smokers, but not in smokers. Due to the potential change in educational attainment and income between 15-30 years, we repeated the analysis in a subgroup of subjects aged 30-69 years and found similar trend and pattern observed among all study subjects. Exclusion of those with asthma diagnosis did not alter the observed associations.

Grigsby et al., (2016) defined SES as an individual’s social and economic standing and serves as proxy for social or economic position or rank in a social group. More than a measure of income, SES encompasses several other measures including education, occupation, housing, assets, and participation in social organization. While lower SES was found to be associated with greater COPD morbidity and mortality in HIC, few studies have examined the role of low SES in the prevalence of COPD among LMICs. An understanding of the role of SES and COPD in LMICs will potentially inform public interventions beyond harm reduction, i.e., tobacco cessation and decreased biomass fuel smoke exposure, toward those aimed at disparities in SES. Analysis using multivariable alternating logistic regression showed that the odds of having COPD was positively associated with use of biomass as a primary fuel source for cooking, daily smoking, not having completed secondary education, lower monthly household income, and older age. We found a positive association between the odds of COPD and a lower SES composite score, with an interquartile OR of 1.23 (95% CI 1.05–1.43). In sensitivity analyses, the positive association between low SES and COPD remained significant (interquartile OR 1.29, 95% CI 1.12–1.50) when we used the GLI Caucasian reference population. In further sensitivity analyses, we analyzed differences using pack-years and categories of smoking history (current, former, or never smoker) instead of daily smoking or not, while adjusting for age, sex, biomass fuel smoke exposure, and site. The interquartile OR for SES was 1.20 (95% CI 1.01–1.41) when using pack-years and 1.18 (95% CI 1.03–1.34) when using categories of smoking history. These results were very similar to using daily smoking vs not (interquartile OR for SES of 1.23, 95% CI 1.05–1.43).

Kanervisto et al., (2011) conducted a study with low education, low income and other risk factors associated with the development of asthma (n = 338) and COPD (n = 588) included those with both diseases (n = 96) by univariate and multivariate logistic regression. Low education. low income and other risk factors associated with the development of asthma (n = 492) and COPD (n = 242) excluded those with both diseases (n = 96) by univariate and multivariate logistic regression. Obesity increased the risk for asthma, whereas underweight increased the risk for COPD (Table 2, Table 3). In the multivariate logistic regression analysis, separately made for both genders, BMI over 30 (OR 1.3, 95% CI 1.0–1.7) and low household income (OR 1.6, 95% CI 1.0–2.4) increased the risk for asthma in women. There were no significant risk factors for men with asthma. In COPD smoking was a risk factor for both genders (women OR 2.5, 95% CI 1.7–3.7 and men 2.3, 95% CI 1.4–3.8). In men underweight was a risk factor for COPD (OR 2.4, 95% CI 1.1–5.0). Basic educational level increased the risk for COPD in both genders (women OR 1.8, 95% CI 1.0–3.3 and men 1.8, 95% CI 1.0–3.0). There was a clear association in the univariate analyses with low education and low household income in both groups. Basic educational level increased the risk of asthma, and the risk of COPD increased if education was lower. Similarly, low household income increased the risk for asthma and COPD. In the multivariate logistic regression analysis when adjusted for gender, age, smoking history, and BMI, the basic educational level remained an independent determinant for COPD and the low household income for asthma. Underweight and smoking were determinants of COPD. Female gender was a determinant for asthma and male gender for COPD. The risk for COPD increased significantly with age, but the connection between age and asthma was not as clear-cut.

Whilst those with an interest in historic workplace exposures may largely regard this relationship as causal, implying that certain work exposures can cause COPD, others may see the clear financial and social disadvantages suffered by COPD patients unable to work.

Old age was reported as a risk factor for COPD by two studies (Alam et al., 2015; Islam et al., 2013). Alam et al., (2015) observed that 50-59 years-aged people and 60-69 years-aged people were two times and five times more likely to develop COPD, respectively, compared to 40-49 years-aged people (50 to 59 years, OR: 2.2, 95% CI, 1.6-3.0; p < 0.001; 60 to 69 years, OR: 4.7, 95% CI, 3.5-6.4; p < 0.001).

During a mean follow-up of 13.5 ± 5.3 years, a total of 2,877 individuals (47.5% men) were discharged from hospital with first-ever COPD as the primary diagnosis. The associations between incidence of COPD and socioeconomic circumstances were presented in Table 2. Low annual income in quartile (Q) 1 and Q2 ((HR: 2.10; 95% CI: 1.83–2.40, P < 0.001 and HR: 2.23; 1.97–2.53, P < 0.001, respectively) were associated with higher risks for COPD. Individuals with rented housing (HR: 1.41; CI: 1.30–1.52, P < 0.001) had higher COPD risk compared to living in self-owned property. Compared to married individuals, divorced (HR: 1.61; CI: 1.46–1.78, P < 0.001) and widowed (HR: 1.30; CI: 1.16–1.46, P < 0.001) individuals had increased risk for hospitalization due to COPD. There was no significant difference in incidence of COPD between Swedish or foreign-born individuals (Borné, Ashraf, Zaigham, & Frantz, 2019).

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