CHAPTER 2
REVIEW OF LITERATURE

The literature pertaining to the present study on Nutritional and Pulmonary Health Status of Textile Women Workers of Tamil Nadu and the Impact of Micronutrient Fortified Food Supplement on Moderate Anaemic Cotton Ginners has been reviewed under the following headings:

2.1 An overview of respiratory disease among cotton textile women workers
2.2 Prevalence, causes and symptoms of pulmonary diseases
2.3 Health and nutritional status of textile workers
2.4 Association between micronutrient and respiratory health
2.5 An overview of food supplementation
   2.5.1 Importance of soya
   2.5.2 Efficacy of soy supplementation on health status
   2.5.3 Micronutrient fortification

2.1 An overview of respiratory disease among cotton textile women workers

Bouhuy et al (2006) explained that the exposure to dust particles lead to respiratory disorders. The fatal disease of byssinosis commonly known as brownlung is seen among people working in the textile industry.

Cotton industry workers are exposed to various hazards in the different departments of the textile factories. Adverse health effects of cotton dust occur in a majority of textile workers. The major health problems associated with cotton dust are respiratory problems which include byssinosis, cough, bronchitis, bronchial asthma and tuberculosis (Mohamud et al, 2004 and Schilling and Molyneux 2008).

Chatterjee et al (2002) stated that a large number of epidemiological studies have shown that concentration of dust particles are associated with
adverse effects on health. These include increased admission of patients to hospitals suffering from heart and lung disorders and a worsening of the conditions of those with asthma. Kamal et al (2004) has clearly mentioned that cotton textile workers who are exposed to cotton dusty sections like carding, drawing, blow room, ring frame etc were identified with chronic bronchitis.

Cotton dust (or) endotoxin exposure cause airway inflammation, asthma, byssinosis, hypersensitivity, pneumonitis and influenza among cotton textile workers (Murray et al, 2003). Similarly, Jugal and Joshi (2001) has opined that occupational health problems are due to high risk occupational exposure to dust (or) endotoxin leading to diseases like pulmonary tuberculosis, asthma, respiratory disease, musculoskeletal disorder, back pain, coronary heart disease in cotton industrial mill workers.

Seateon (2005) has stated that prolonged exposure to dust and fumes causes bronchial irritation, alveolar inflammation, chronic sputum production, air flow obstruction with relatively greater reduction in FEVI resulting in an increased prevalence of such conditions in population.

Pragti (2008) has stated that chronic respiratory disease asthma, chronic obstructive pulmonary disease was found to be higher in textile industries. Mashra et al (2004) has reported that the workers are at risk of suffering from various chronic respiratory illnesses including byssinosis, chronic bronchitis due to exposure of cotton dust in the work sites.

Joshi (2002) has stated that the major occupational diseases of cotton textile worker include pneumoconiosis, chronic obstructive lung disease, byssinosis, musculoskeletal injury and noise- induced hearing loss. Madhu et al (2005) has observed that the main disease condition like headache, respiratory and fever were higher in textile workers.

According to Mehta et al (2006) occupational exposure to cotton dust cause acute respiratory responses such as chest tightness and broncho
restriction and respiratory disease including byssinosis. The long term exposure leads to chronic respiratory disease and excessive loss of pulmonary function.

Glindmayer et al (2001) has found that the textile workers with chest tightness chronic bronchitis, asthmatic bronchitis, eczema, hearing impairments was attributed to high cotton dust concentration in cotton industry.

Holness et al (2004) has identified that an immunological dysfunction may be a risk factor in the development of respiratory disease, induced by cotton dust bearing in mind that cotton dust has a diverse content as described by many investigators, the extent of association between exposure to cotton dust and chronic bronchitis, bronchial asthma and hay fever and also the extent of development of byssinosis and other respiratory problems.

Epidemiologic studies have shown that chronic occupational exposure to organic dust may induce chronic airway disease (Chan-Jeung et al, 2002). Among many agents present in organic dusts, there is substantial evidence to suggest that bacterial endotoxin is a major causative agent that contribute to airway inflammation and airflow obstruction (Rylander et al, 1999).

Morgan(2003) has stated that occupational lung diseases resulting from inhaled organic dusts include: asthma, hypersensitivity pneumonitis, bronchitis and certain “flu-like” illnesses such as those resulting from endotoxin, exposure complaints may occur singly (or) as a part of a “symptom complex” as seen in workers exposed to cotton flax (or)hemp dust.

Karnik et al (2000) has stated that Byssinosis is a chronic respiratory disease of cotton, Flax and Soft hemp workers. The workers exposed to cotton dust in textile mills showed significant rise in IGC with (or) without byssinosis and IgA and IgM increased only in byssinosis.

Byssinosis is a disease that affects workers employed in the cotton occupation. In its earliest stages, workers complaint of chest tightness and
shortness of breath. In the later stages, workers display irreversible pulmonary impairment (Jacob et al, 2006).

Rajnarayan et al (2001) has reported that the various morbid conditions among cotton textile workers included amebiasis, grade ½ byssinosis, chronic bronchitis, dental stain eosinophilia, hypertension, iron deficiency anaemia and upper respiratory infection.

Jiang (1999) has stated that chronic industrial disease associated with the inhalation of cotton dust over long periods of time result in feeling tightness in the chest (or) shortness of breath, dry cough and phlegm.

The term byssinosis is derived from a Greek word which means fine linen (or) flex was introduced by proust in 1877 as the name for the respiratory disease peculiar to textile workers that was characterized by chest tightness at the beginning of the working week (Richard and Schilling 1999).

John (2004) has defined that byssinosis, a respiratory disease of workers on cotton, flax and hemp is classically characterized as shortness of breath, cough and clean chest tightness on Monday or the first day of return to work after a time off. Exposure to this vegetable dust can also result in other respiratory diseases and the term Cotton Dust Induced Respiratory Disease (CDIRD) and allergic pathogenesis.

Jonathan and Lesotha (2006) has reported that workers in textile industry suffered from respiratory complaints related to exposure to cotton fabric dust; some of the symptoms resembled those of byssinosis, impaired pulmonary functions, musculoskeletal disorders, and skin problems which are believed to be associated with exposure to cotton dust and fabric dust.

Jindal (2003) has explained that the inhalation of dust is an important cause of interstitial lung disease in the tropical countries such as India. While dusts of organic origin, such as the cotton dust causes byssinosis and generally
causes bronchial (or) bronchiolar involvement and hypersensitivity pneumonitis.

2.2 Prevalence, causes and symptoms of pulmonary diseases

According to World Health Organization and World Bank Global Burden of Disease, the global prevalence of chronic obstructive pulmonary disease was found to be 9.22 per 100 individuals for men and 7.33 per 100 for women. The prevalence was observed to be higher in industrialized countries (Rylander et al, 2002).

Kamat et al (2004) has stated that the prevalence of respiratory problems among textile workers has increased from 13 per cent to 18 per cent with prolonged duration of exposure from less than 15 years to more than 40 years.

Zuskin et al (2006) has recorded the various respiratory symptoms such as chronic cough (Female: 60 to 50 per cent; male 24.8 to 60 per cent) followed by chronic phlegm (Female : 60 to 28.9 per cent; Male : 22.8 to 61.9 per cent), dyspnea (Female: 9.2 to 57.6 per cent; Male : 5.5 to 33.3 per cent) and nasal catarrh (Female : 5.7 to 65.9 per cent ; Male : 4.1 to 38.7 per cent) prevalent across all exposed groups. Female workers complained of significantly less chronic phlegm than did men (p <0.01) but had significantly higher prevalence of nasal catarrh and dyspnea than men (p <0.01). The highest prevalence of occupational asthma in women was found in ginning workers (10.5 per cent) and the highest prevalence in men was found in spinning workers.

In a study of Mustajbegovic et al (2000) occupational asthma was reported in 0.5 per cent of men and in 1.5 per cent of women who occupationally exposed to low concentrations of organic and inorganic air pollutants in the textile industry. Sobradillo et al (2004) diagnosed occupational asthma in 4.2 to 5.5 percent of women and 38 to 5.9 percent of men in the general population. Nejjarí et al (2002) studied the prevalence of asthma related to occupation and found that the prevalence rate in men was 7.3
per cent and 5.2 per cent in women and the prevalence of chronic bronchitis was 20 per cent in males and eight per cent in females.

Jaiswal (2007) has observed that cough was the most common symptoms in both the groups but was significantly more among textile workers (53.66 per cent) when compared to non-textile workers (9.33 per cent). Next common symptom was chest pain and that too was more common among textile workers (32.66 Vs 8.33 per cent). Likewise Breathlessness (11 Vs 3.66 per cent) along with fever (28.66 Vs 2.00 per cent) was also more common among textile workers.

The overall prevalence of chronic cough, chronic phlegm and dyspnea were in 2.0, 1.2 and 3.4 per cent of women respectively. In India, population-based studies on the prevalence of chronic obstructive pulmonary disease have been conducted. These studies have reported figures ranging from 1.4 to 9.4 percent in males and 1.3 to 4.9 per cent in females (Ait-Khaled et al, 2001) In a review, on population studies(Jindal et al, 2001 ) a median figure of five per cent for males and 2.7 per cent for female have been recorded.

Jannet et al (2006) has reported that 65.7 per cent manifested bysssinotic symptoms, 23.7 per cent with chronic bronchitis symptoms and 10.53 per cent with occupational asthmatic symptoms. They had significant reduction in pulmonary function parameters about five per cent level forced expiratory volume in one second and one per cent level in Peak Expiratory Flow Rate.

The low peak expiratory flow rate was identified among 52.9 per cent of workers. Among them, 42.9 per cent had symptoms of cough with or without phlegm; 5.7 per cent had a history of chronic bronchitis and/or asthma, and 4.3 per cent experienced chest tightness breathlessness. This study showed a high degree or respiratory related illness symptoms present among the workers in the blow/card rooms and in the spinning section (Ahusan et al, 2006).
The prevalence of byssinosis was 43.2 per cent among blowers and 37.5 per cent in carders in comparison with 4 to 24 per cent among workers in other sections. The prevalence of chronic bronchitis ranged from 17.6 to 47.7 per cent and bronchial asthma from 8.5 to 20.5 per cent across all sections (Woldeyohannes et al, 2005).

Schacter (2009) has noted the chronic respiratory symptoms such as chronic cough (31.6 per cent), chronic phlegm and chronic bronchitis (15.8 per cent), Dyspnea (31.6 per cent) nasal catarrh (52.6 per cent) and sinusitis (37.2 per cent) and occupational asthma (3.5 per cent) were much evident among the female textile workers of Ethiopia.

Cotton textile workers suffer from variety of respiratory disease because of exposure to cotton dust. It has been clearly mentioned by Mabmoud et al (2004) that in India textile workers of blending and picking department, carding and spinning department and combing and twisting department suffer from cough (68.3, 60.2, and 73.7 per cent respectively) chest pain (68.3, 60.2, 57.6 and 64.9 per cent respectively), and dyspnea (70.7, 68.1 and 71.9 per cent respectively). It was observed that 13.4, 11.1 and 2.3 per cent were suffering from chronic bronchitis, chronic bronchitis with emphysema and bronchial asthma respectively and 13.4 per cent of workers had sensory deafness.

Dust are solid particles generated by handling, weaving, cutting polishing and washing include organic and in organic materials, such as cotton, fibre, hemp, silk and jute. The exposure of cotton dusts can lead to a wide variety of respiratory disease, including pulmonary fibrosis, obstructive lung disease, allergy and lung cancer. Toxic dusts may produce systemic poisoning after inhalation, or act as skin irritants to produce derma tomes, allergic reactions and cancer (Wang et al, 2005).

Textile workers are generally exposed to organic dust, cotton dust (or) wool dust which is known to cause respiratory morbidity (Ozesmi et al, 2001). Common practice among the workers to use stimulant like tobacco and betal
leaves during working hours leads to fall in ventilatory capacity and cause respiratory problem (Fox, 2006).

The occupational lung disorders according to the biological properties of the material inhaled were grouped in to three main types (i) Disorders caused due to exposure to mineral dust (Coal dust, silica, asbestos and iron etc); (ii) Disorders caused due to exposure to gases and fumes (ammonia, Chlorine sulphur dioxide etc); (iii) Disorders caused due to exposure to organic dust (mouldy hay, cotton dust, Fibre and Jute etc) (Crofton, 2007).

Schilling et al (2002) stated that when exposed to dust for the first time, develop an acute, airway reaction with often substantial fall in forced expiratory volume in one second (FEV) and forced vital capacity (FVC) and later develop an irreversible respiratory disease called byssinosis.

Women working in industry sections like carding blowing, ring frame, and spinning etc were found to be associated with higher prevalence of cough, headache, dyspnea, backpain, fever, cold, wheezing and chronic bronchitis (Awadel et al, 2005).

The most frequent complaints reported by textile workers were ache and respiratory disorders. Respiratory disorders may be due to the dusty work environment. The major health problems associated with cotton dust were respiratory problems including byssinosis, cough, bronchitis and bronchial asthma (Molyneux and Tombleson, 2003). Other disease conditions are musculoskeletal pains, headache, easy fatigue and change in blood pressure (Heington, 2005). Textile workers suffered from aches (body ache, backache) almost twice as much as the comparative group indicating textiles workers are highly exposed to physical labour which affects their musculoskeletal systems (Batawi, 2005).

Low back pain is one of the most common health problems in industrialized societies. It is defined as a non specific condition that refers to
complaints of acute or chronic pain and discomfort in or near the lumbosacral spine which can be caused by inflammatory degenerative, neoplastic, gynecological traumatic, metabolic and other type of disorders (Last et al., 2006).

Ananthan et al. (2000) has found various morbid conditions among cotton textile workers. They were amoebiasis (4.1 per cent) grade ½ byssinosis (2.3 per cent), chronic bronchitis (4.5 per cent), dental stains, (5.6 per cent), eosinophilia (19.8 per cent), hypertension (1.9 per cent), Iron deficiency anemia (52.7 per cent) and upper respiratory infection (45.5 per cent) etc.

Mortin et al. (2003) has noticed complaints like dry cough, chest tightness, breathlessness and burning of eyes in 39.1 per cent of gin workers. Tiwari et al. (2001) has stated that respiratory symptoms could also be attributed to non-respiratory conditions like anemia, systematic hypertension, etc.

### 2.3 Health and Nutritional status of textile workers

Textile industry is one of the sectors which furnishes semi skilled job to illiterate population in our country. At present majority of illiterate women are employed in the textile industries. In spite of the improvement in textile technology the work environment has not changed much. Even today women are working with low wages in minimum physical comforts. Many research reports have highlighted that women working in textile industries are suffering from musculoskeletal aches, respiratory allergies, bronchitis, visual impairments, and tuberculosis (Madhu, 2010).

Saha (2010) has stated that the majority of women workers had to perform their house hold activities in addition to their work, and as a result of this family care was affected. Women had little time to take rest to attend their personal health problems and to social engagements. Musculoskeletal problems were the commonest health problem prevailing among these populations. This may be explained by the fact that their work required them to remain in a bent
position for many hours at a stretch, often in an over crowded, ill-ventilated and poor illuminated room. Similar findings were reported by Surat (2007) who mentioned that musculoskeletal disorders being the most common hazard in women engaged in spinning and the neck being the most commonly affected part, followed by the low back.

Guo (2004) has reported that workers generally complained musculoskeletal disorder of mainly neck, back, shoulders, hands and wrists. Stress at work is a growing problem for all workers, especially women. Many of the job conditions, along with the problem of balancing work and family issues, contribute to stress in the work place (Benade, 2001).

Ananathan (2000) has reported that 44 percent of the cotton mill textile workers of study population have other ailments like body ache, headache, soriasis, defective eye sights, dental problem, hypertension and diabetes and this might be due to aging, poor nutrition diet, low hemoglobin content and heavy work.

The studies of (wang et al, 2004) have highlighted that 59.7 per cent of women working in cotton mill suffered from dysmenorhoea. Kalantali (2006) pointed that the majority of the textile workers showed health problems such as loss of interest, amnesia (sleeplessness), loss of precision and fatigue.

Chandra Sekaran (2003) has found that increased number of workers had complaint about psychological stress and overworks. These psychological factors strongly associated with sleep disturbance and depression as well as elevated blood pressure leading to hypertension.

Morbid conditions identified among cotton textile workers were generalized weakness, menstrual problem, insomnia, vision problem, skin disease, anemia, angular stomatitis hypertension, malnutrition, fever and pain in abdomen. The ill health was compounded by various socio economic factors such as poverty, lack of education, poor working condition, excess working
hours, decreased consumption of fruits and vegetables and poor diet (Kaila, 2000).

Bozina et al (2005) has stated that underweight with low Body Mass Index and decreased muscle mass leads to marginal malnutrition. Malnutrition including subclinical vitamin and mineral deficiency would affect some vital function such as physical work capacity, immunological competence, cognitive function and behaviour.

According to Daniel et al (2008) underweight is a poor prognostic sign in pulmonary disease. It is also clear that under nutrition is at least in part associated with the severity of air flow obstruction. So active nutritional supplementation is needed for weight gain and improvement in respiratory muscle function.

Kumar and Vali (2008) has reported that micronutrient iron has the clearest relationship with physical work capacity, deficiency leads to low Body Mass Index with reduction is lean tissue, serum albumin levels and Vo$_2$ max. Overall morbidity was significantly higher in textile workers suffering from anemia is in 71.3 percent compared to those without anaemia 28.7 per cent. The anemia can be cured through prompt attention to nutritional food (Johnbeard, 2000).

Sabiha (2002) has mentioned that prevalence of iron deficiency anemia is common among Indian women, since cereals are significant sources in Indian diet and women are prone to iron and B complex deficiencies. However, poor consumption of protein rich food causes protein calorie malnutrition, lack of consumption of milk lead to riboflavin deficiency. The vitamin C deficiency signs are swollen and bleeding gums which are attributed to low intake of fruits and green leafy vegetables. Higher intake of nutritious food items, help to prevent the deficiency signs to a greater extent.
Rao and Ramnath (2008) has noted in their study that average daily consumption of energy, protein vitamin A, thiamine, riboflavin, ascorbic acid, iron were below the recommended dietary allowances among the industrial women workers. The clinical signs of nutritional deficiencies were, Vitamin A (2.6 per cent) B Complex (2.7 per cent), angular stomatitis (8 per cent) and iron (50 per cent).

According to Web (2002) malnutrition adversely affect lung structure and its function, respiratory muscle strength endurance of immune defense mechanism and difficulty in breathing. The relationship between malnutrition and respiratory disease has long been recognized with starvation, respiratory muscle mass strength endurance and efficiency decline. Both respiratory muscle strength and its function can be improved with nutrition repletion.

Protein supplementation can increase oxygen consumption (from its thermic effect) increased the ventilatory response to hypoxemia and hypercarbia that may potentially result in dyspnea in respiratory limited subjects reported by (Weisman et al., 2004).

Malnutrition of workers increases their susceptibility occupational related diseases and disorders paving the way for the completion of vicious cycle of malnutrition (Rajkumar and Premakumari 2000).

Banerjee (2006) has witnessed phenomenal industrial progress among the developing countries including India. The nutrient intake of calories, protein, iron were lower than the recommended dietary allowances. Among the industrial women workers 60 per cent were under nourished and malnourished, 70 per cent had protein and iron deficiency signs.

Optimum health and work capacity of working women can be achieved and maintained if adequate steps are taken to reduce the occupational stresses, improve their diet and provide adequate occupational health care and nutritional education (Rajkumar and Premakumari, 2000).
Lia *et al* (2003) has conducted a study among cotton textile women workers and observed that 44.8 per cent were undernourished, 65 per cent had protein deficiency, and 75 per cent with iron deficiency which affected their cognitive function, behavior and work efficiency. Vasantha (2001) opined that iron deficiency anemia affects the physical capacity of workers by reducing the availability of oxygen to the tissue which in turn affects cardiac output.

Layanun (2003) has found that the diet of the textile worker was deficient in calories (2.5 per cent), protein (5.9 per cent), iron (10 per cent) and β-carotene (12 per cent) because the workers consume only small quantities of pulses and non leafy vegetables. Leafy vegetables were consumed occasionally. Majority of the workers were non vegetarian but they consume rarely due to poor economic reason. Fruits, milk are consumed in insufficient quantities. Hence the improper diet leads to nutritional deficiency like protein calorie malnutrition, Vitamin A, B and C deficiency.

Shilling (2004) has reported that 35 and 20 per cent of women were taking three and two meals per day respectively. Sixty percent of women were not taking breakfast and 15 per cent frequently did not have dinner. He opined that the percentage of women with completely correct eating habits was low and the most important drawback of the nutritional habits was the infrequent consumption of fruits and green leafy vegetables.

Among 111 women workers, 79.3 per cent consumed calories less than the recommended. Similarly, even among those who were of normal Body Mass Index (80.3 per cent) consumed low calories than the required amount. This probably demonstrates that the under nutrition in this group of workers is more likely due to the inherently deficient calorie intake among them (Joseph, 2005).
The adequate intake of iron by an individual per day is 30 mg. But it was found that none of the workers interviewed consumed adequate amount of iron. Incidentally 35 per cent of these workers had clinical signs of anemia (Chandrasekhara, 2002).

2.4 Association between micronutrient and respiratory health

Nutritional depletion in patients with respiratory disease is common and has a negative impact on respiratory and peripheral muscle function. Therefore assisting patients with respiratory disorder to attain and maintain optimal nutritional status is crucial to enhance their physical wellbeing and function (Raherison et al, 2009).

Our body is a huge structure with trillions of cells. Every cell depends on oxygen to keep itself alive. No cell directly exchanges gases as we do, but these gases in turn are ultimately used by the whole body cells. Every cell needs to respire in order to produce energy. Respiration takes place in the mitochondria of every cell in our body. It is the process of converting glucose and oxygen into energy. Glucose is transported across cell membrane of a cell with the help of a carrier. Oxygen requires an iron complex for carrying itself from lungs to the rest of the cells (Sharma , 2008).

Iron is vital for almost all living organisms by participating in a wide variety of metabolic processes, including oxygen transport, DNA synthesis, and electron transport. However, iron concentrations in body tissues must be tightly regulated because excessive iron leads to tissue damage, as a result of formation of free radicals. Disorders of iron metabolism are among the most common diseases of humans and encompass a broad spectrum of diseases with diverse clinical manifestations, ranging from anemia to iron overload and possibly to neurodegenerative diseases (Lieu et al , 2001).

Iron is essential to the process of oxidation in the body. It is a constituent in compound which are necessary for the transport of oxygen to the
cell and oxidation in the cell. The human body contains 75mg/kg fat free body weight i.e. In adults, its amount is 3.5g. Iron is also present in erythrocytes of blood and in serum in ferric form bound to a specific B-globulin, transferring (siderophilin). The quantitative ability of transferrin to build iron is known as “Iron – binding capacity” of serum. Practically no ironic iron exists in the animal body. About 26 percent of the total body content of iron is stored in the cells of liver, spleen and bones as ferritin and hemosiderin (Sharma, 2008).

Iron is essential in the production of haemoglobin (Hb), which participates in the delivery of oxygen from the lungs to the body tissues, electron transport in cells, and in the synthesis of iron enzymes that are required to use oxygen for the production of cellular energy (Monarrez et al, 2001)

Haemoglobin is the major part of red blood corpuscle; it is an iron containing protein. Haem is the central part of the Haemoglobin and it is the part which contains iron is an iron complex. During exchange of gases O₂ and CO₂ it makes a bond with the molecules of these gases for transportation. This oxygen is released in the whole of the cells of the body which is then required for the respiration. In reverse, carbon dioxide is taken from the cells and this is also carried by the hemoglobin to the lungs for exhalation. In lack of iron the transportation of the gases becomes weak. It causes degradation of cells due to poor nourishment. So the deficiency of iron which is called as anaemia (lack of haemoglobin in body) may be fatal in severe condition (Sharma, 2008).

Hemoglobin is involved in the transport of other gases: it carries some of the body's respiratory carbon dioxide (about 10 per cent of the total) as carbaminohemoglobin, in which CO₂ is bound to the globin protein. The molecule also carries the important regulatory molecule nitric oxide bound to a globin protein thiol group, releasing it at the same time as oxygen (Fleming et al, 2005).
Most well-nourished people in industrialized countries have 4-5 grams of iron in their bodies. Of this, about 2.5 g is contained in the haemoglobin needed to carry oxygen through the blood. Another 400 mg is devoted to cellular proteins that use iron for important cellular processes like storing oxygen (myoglobin), or performing energy-producing redox reactions (cytochromes). 3-4 mg circulates through the plasma, bound to transferrin (Connie et al, 2001).

Several lung diseases have been associated with oxidative stress and linked to oxidant insults such as cigarette smoke, air pollutants and infections. Consequently, dietary factors and nutrients with a potential protective role in the oxidative process and inflammatory response have been implicated in the genesis or evolution of these diseases. These nutrients include fruits and vegetables, antioxidant vitamins such as vitamin C, vitamin E, betacarotene and other carotenoids, vitamin A, fatty acids and some minerals such as sodium, magnesium and selenium (Romieu, 2005).

Vitamin C, a water-soluble vitamin, is an abundant antioxidant substance and is widely distributed throughout the body including the extracellular lining fluid of the lung. Ascorbate is an excellent reducing agent and scavenges free radical and oxidants. In vitro evidence suggests that vitamin C has a role as a chemical reducing agent both intracellularly and extracellularly. Intracellular vitamin C might prevent protein oxidation and regulate gene expression and mRNA translation. This is particularly relevant for the lung which is exposed to oxidative substances. Extracellular vitamin C protects against oxidants and oxidant-mediated damage (Levine et al, 2006).

According to Romieu(2005)antioxidant vitamins, particularly vitamin C, and to a lesser extent other antioxidants, have a protective effect against lung diseases. Supplementation of vitamin C and other antioxidants could be proposed in subjects with additional oxidative stress challenge, such as
exposure to high levels of air pollution. Subjects with impaired immune response could also benefit from vitamin A and zinc supplementation.

Ascorbic acid enhances iron absorption by keeping it in the ferrous form. This is due to the reducing property of vitamin C. It helps in the formation of ferritin (storage form of iron) and mobilization of iron from the ferritin. Vitamin C is useful in the reconversion of methenoglobin to haemoglobin. The degradation of haemoglobin to bile pigment requires ascorbic acid (Johri, 2004). Ascorbic acid may enhances the availabilities and absorption of iron from non-haem sources (Eiserich et al, 2001).

Iron requirement remains the same despite the current lower energy requirement. This means that more iron must be absorbed per unit energy. A higher bioavailability of the dietary iron can be achieved by increasing the content of food components enhancing iron absorption (ascorbic acid, meat/fish) or by decreasing the content of inhibitors (e.g. phytates, tannins). The latter is not feasible considering the recent and reasonable trend towards increasing the intake of dietary fibre. The key role of ascorbic acid for the absorption of dietary non-haem iron is generally accepted. The reason for its action are two folds, (i) the prevention of formation of insoluble and soluble iron components and (ii) the reduction of ferric to ferrous iron, which seems to be a requirement for the uptake of iron in the mucosal cells (Rossander, 2003).

According to data presented at the 20th Annual Congress of the European Respiratory Society a diet rich in antioxidants may protect one of the body against the progression of chronic obstructive pulmonary disease and even improve lung function. Fruit and vegetables contain significant amounts of antioxidant vitamins such as vitamin C, E and beta-carotene, which may protect the lungs from oxidative damage resulting from smoking and/or air pollution. Those vitamins exert antioxidant and anti-inflammatory properties, support the normal hydration of airway surfaces and convert oxygen radicals to
less-reactive forms. “These findings suggest that a diet rich in antioxidants such as fruit and vegetables may be associated with favourable outcomes in respiratory diseases (Keranis, 2010).

People with respiratory diseases expend more energy for breathing. A progresses symptoms such as shortness of breath, taste alterations due to dry mouth, fatigue, early feelings of fullness, etc. can contribute to decreased food intake. A prolonged decrease in food intake can lead to significant weight loss and malnutrition (Cockburn, 2009).

Intake of antioxidants namely vitamin C, vitamin E and beta-carotene are found to be positively associated with lung function. High levels of dietary fiber appear to be beneficial to lung function while lowering the risk of respiratory disease and respiratory symptoms. Increase intake of flavonoids may enhance lung function and reduce respiratory symptoms. Recent studies have also suggested that some n-3 and n-6 fatty acids may offer protection against respiratory risk and mortality (Hirayama, 2010).

People who have a diet rich in fruit and vegetables have a lower risk of poor respiratory health, and that this may be due to the antioxidant nutrients present in these foods. On the basis of the evidence, it seems justified to promote a healthy diet, high in fruits, vegetables, and whole grain foods and low consumption of alcohol and fatty foods, as set out in existing guidelines for the prevention of cardiovascular disease and cancer, to protect respiratory health in both children and adults (Denny, 2003).

Studies of lung function decrement and COPD in adults suggest that daily intake of vitamin C at levels slightly exceeding the current Recommended Dietary Allowance (60 mg/day among nonsmokers and 100 mg/day among smokers) may have a protective effect (Schunemann et al, 2001).
Among the vitamins and supplements that can help to reduce inflammation are omega-3 fatty acids, which are essential fatty acids that can also aid in oxygen transfer and in reducing mucus production. Vitamins like folic acid and other B vitamins, Vitamin C, and Vitamin D also have anti-inflammatory properties. Deterioration of the immune system is a frequent companion of Chronic Obstructive Pulmonary Disease, leaving the sufferer vulnerable to bacteria, viruses, respiratory infections, and pneumonia. Among the vitamins and minerals that are helpful in supporting the immune system are A vitamins, B vitamins, vitamin C, and zinc (Surat, 2002).

Data also suggest that ω-3 fatty acids may have a potentially protective effect against airway hyper reactivity and lung function decrements (Romieu, 2001). Muscle and other body tissues are composed of protein. Experts believe the need for protein may increase as we age. It is important that people with respiratory disease eat a good source of protein at least twice a day to help maintain strong respiratory muscles (Joswer, 2011).

Cai et al (2003) demonstrated that pulmonary function in chronic obstructive pulmonary disease patients can be significantly improved with a high fat, low carbohydrate oral supplement as compared with the traditional high carbohydrate diet.

Macronutrient intake patterns may directly influence the adequacy of gas exchange by leading to variable CO₂ production. Every molecule of carbohydrate ingested results in a molecule of CO₂ produced; therefore, the respiratory quotient of carbohydrate has a value of 1. The respiratory quotient of protein is 0.8, whereas that of fat is 0.7. Protein supplementation may increase oxygen consumption due to its relatively high thermic effect. Protein consumption also tends to increase ventilation, potentially leading to dyspnea in patients with limited reserve (Charbel, 2010).
Tumbi and Dodd (2003) has found the effect of iron supplementation (ferrous fumarate) on the iron status and physical work capacity in anaemic middle class Maharastrian women. It was observed that 60 per cent were anaemic so the supplementation was given to them. There was increase in hematological, biochemical parameters and work performance and showed the significant improvement.

Micronutrient deficiency is associated with an impairment of immune responses and increased susceptibility to infections like upper and lower respiratory tract infections (URI/LRI) To combat the micronutrient deficiencies especially IDA several intervention programmes have been initiated. The most commonly adopted strategy is the dietary supplementation could be an effective, preventive and curative strategy, in contrast to dietary diversification and food fortification, in providing immediate relief (Sangeetha and S. Premakumari 2010)

Kelly et al (2003) found the relationships between dietary consumption of fruit, vegetables and fish, and plasma levels of vitamins A, C, E and β-carotene, and pulmonary function (forced expiratory volume in one second (FEV1)) and symptoms (phlegm production and shortness of breath with wheezing), were examined in a random population sample of adults. A dose/response relationship was found between fruit consumption and pulmonary function. In comparison with eating fruit rarely or never, eating fruit at least once per day, 1–6 times per week, and 1–3 times per month were associated with differences of 132, 100 and 63 mL in FEV1, after adjustment for known confounders and dietary intake of vegetables and fish (n=6186). An SD score change in plasma vitamin C was associated with a 49 mL difference in FEV1 (n=930). Fruit and vitamin E were associated with a reduced prevalence of phlegm production for 3 months or more per year. The most beneficial combination of dietary components may be found in natural food stuffs, particularly in fresh fruits.
Epidemiologic studies have indicated that a diet rich in fruit, antioxidants, and n-3 fatty acids may contribute to optimal respiratory health. Low dietary fruit intake was associated with lower FEV\(_1\) (−1.3% of predicted; 95% confidence interval [CI], −2.4 to −0.2% of predicted), and increased odds of chronic bronchitic symptoms (1.36; 95% CI, 1.03 to 1.73) compared with higher intake. Low dietary n-3 fatty acids intake was associated with increased odds of chronic bronchitic symptoms (OR, 1.37; 95% confidence interval [CI], 1.05 to 1.81), wheeze (OR, 1.34; 95% CI, 1.06 to 1.69), and asthma (OR, 1.68; 95% CI, 1.18 to 2.39) compared with higher intake. Adolescents with the lowest dietary intakes of antioxidant and anti-inflammatory micronutrients had lower pulmonary function and increased respiratory symptoms, suggesting that adequate dietary intake may promote respiratory health and lessen the effects of oxidative stress (Jane et al, 2007).

Menkes et al (1986) explained the relation of serum vitamin A (retinol), beta-carotene, vitamin E, and selenium to the risk of lung cancer, using serum that had been collected during a large blood-collection study performed in Washington County, Maryland, in 1974. Levels of the nutrients in serum samples from 99 persons who were subsequently found to have lung cancer (in 1975 to 1983) were compared with levels in 196 controls who were matched for age, sex, race, month of blood donation, and smoking history. A strong inverse association between serum beta-carotene and the risk of squamous-cell carcinoma of the lung was observed (relative odds, 4.30; 95 percent confidence limits, 1.38 and 13.41). Mean (±SD) levels of vitamin E were lower among the cases than the controls (10.5±3.2 vs. 11.9±4.90 mg per liter), when all histologic types of cancer were considered together. In addition, a linear trend in risk was found (P = 0.04), so that persons with serum levels of vitamin E in the lowest quintile had a 2.5 times higher risk of lung cancer than persons with levels in the highest quintile.
Textile industry in Bangladesh and employs 1.6 million female workers. Due to the indoor lifestyle and low dietary intake of calcium, it was assumed that they are at risk of low vitamin D and bone mineral status. Two hundred female garment workers (aged 18-36 years) were randomly selected. Serum 25-hydroxyvitamin D (S-25OHD), serum intact parathyroid hormone (S-iPTH), serum calcium (S-Ca), serum phosphate (S-P) concentration and serum alkaline phosphatase activity (S-ALP) were measured from fasting samples. Bone indexes of hip and spine were measured by dual-energy X-ray absorptiometry. The mean S-25OHD (36.7 nmol/l) was low compared to that recommended for vitamin D sufficiency. About 16% of the subjects were found to be vitamin D-deficient (S-25OHD 21 ng/l) was associated with progressive reduction in bone mineral density at the femoral neck and lumbar spine. According to the WHO criteria, the mean T-score of the femoral neck and lumbar spine of the subjects were within osteopenic range. The high prevalence of hypovitaminosis D and low bone mineral density among these subjects are indicative of higher risk for osteomalacia or osteoporosis and fracture (Islam et al., 2008).

Nyagosya et al (2005) Range formulated recently a multi micronutrient and zinc supplement for pulmonary tuberculosis patient in Tanzania. The selected PTB patient was fed with multi micronutrient gained 0.78 kg (95% CI: 0.12–1.43, P ¼ 0.02) more weight than those allocated to placebo. The weight gain did not differ between those allocated to zinc and placebo (0.26 kg, 95% CI: 0.40 to 0.92, P ¼ 0.44). The effect of multi micronutrient and zinc on weight gain did not differ.

Roth (2008) confirmed that routine zinc supplementation for more than three months does have a positive effect on reducing the duration of acute lower respiratory tract infections among children in developing countries. These effects observed could translate into major absolute reductions in childhood morbidity and mortality rates given the numbers of children who die from acute lower respiratory tract infections every year. It remains important to
better understand how zinc may also work in conjunction with antibiotics in the
treatment of children with severe acute lower respiratory tract infections and to
reduce the number of child deaths due to pneumonia.

2.5 An Overview of food supplementation

2.5.1 Importance of soya

The typical composition of the soya bean is 18 percent oil 38 percent
protein 15 per cent insoluble carbohydrate (dietary fiber) 15 percent soluble
carbohydrate (sucrose, stachose raffinose and others) and 14 per cent moisture,
ash and other (Surat, 2001)

Ternando (2003) said that Soya bean has been considered as a valuable
safe and inexpensive source of protein and it contain 40 percent protein for
convenience purpose, these four key amino acids arginine glutamine, leucine
and valine have been termed as the critical cluster. The sum of these four
amino acids is highest in soya protein as compared with other typical proteins
used in foods created for sports performance (Thomas ,2002)

Erickson (2003) explained that soya protein products fall in 3 major
groups. The use fat flour is soya bean from which hull have been removed.
Partially defatted extruded expelled flour are soybeans from which hulls and
some oil has removed and defatted soy flour are soy beans from which hull and
oil is removed.

Soya beans contain about 40per cent protein and upto 20 per cent fat
whole soya beans are good source of calcium, iron, zinc phosphorus,
magnesium, thiamin, riboflavin, niacin and folacin.(Venter, 2000)

Potter (2004) opined that soy lowers blood cholesterol The cholesterol
lowering effect of soy has been attributed to isoflavones a class of
phytochemical found in soya bean. Widhalm et al (2002) reported that daily
intake of 20-50 grams of isolated soy protein could result in a 20 – 30 per cent reduction in heart disease.

The soya based products can help to control weight by providing high quality protein in a concentrated form and can be met in specifically designed low calorie high nutrient and ready to eat meals (Edward, 2005).

Setcheel et al (2007) depict that soya protein is highly digestible (92 – 100 percent) and contain all essential amino acid. Although relatively low in methioninie it is a good source of lysine. It contain high concentration of isoflavones.

Slaon (2000) reported that soy protein supplies all nine essential amino acids and provide many functional benefits of food processors and for healthy diet. It promotes moisture, flavour retention, emulsification and enhance the texture to many product and it is equal to the animal protein.

Consumption of soy foods is increasing because of reported beneficial effects on human nutrition and health. These effects include lowering of plasma cholesterol and prevention of cancer, diabetic and obesity as well as protection against bowel and kidney diseases (Hamilton and Caroll, 2006).

Stauffer (2006) opined that nutritionally and functionally soy flours do the same job more economically. In bakery products cereals and pasta, soy protein ingredients are being used for a variety of economical functional as well as nutritional reason. Because of price and the compatibility of particular vegetable fiber with most bakery products, defatted soy flour is most widely used.

Faller et al (2000) reported that defatted soy flour are added to cake, bread, pancakes and many other baking mixes at level of 2 per cent to 15per cent. The defatted soy flour is used for making pasta product like macroni, spaghetti and it is used for cookies formulation.
2.5.2 Efficacy of soy supplementation on health status

Washburn et al (1999) investigate that the effect of soy protein supplementation with known levels of phytoestrogens on cardiovascular disease risk factors and menopausal symptoms in perimenopausal women. A randomized, double-blind crossover trial was conducted in 51 women consuming isocaloric supplements containing 20 g of complex carbohydrates (comparison diet), 20 g of soy protein containing 34 mg of phytoestrogens given in a single dose, and 20 g of soy protein containing 34 mg of phytoestrogens split into two doses. Women were randomly assigned to one of the three diets for 6-week periods and subsequently were randomized to the remaining two interventions to determine whether differences existed between the treatment diets for cardiovascular disease risk factors, menopausal symptoms, adherence, and potential adverse effects. Supplementation in the diet of nonhypercholesterolemic, nonhypertensive, perimenopausal women resulted in significant improvements in lipid and lipoprotein levels, blood pressure, and perceived severity of vasomotor symptoms. These data corroborate the potential importance of soy supplementation in reducing chronic disease risk in Western populations.

Radhakrishnan et al (2008) found that 25 gm of soy supplementation with 75 mg of isoflavones in postmenopausal women improves estrogen deficiency symptoms and also improves lipid profile. Reduction in total and LDL-cholesterol without inducing hypertriglyceridemia is an advantage over estrogens. Soy proteins were found to have an added advantage of reduction in triglycerides in term of cardiovascular health.

The role of soy phytoestrogens in preserving bone health has to date not been studied in large randomised controlled studies. These bioactive naturally occurring compounds are viewed as potential selective oestrogen receptor modulators based on their structural similarity to oestradiol, in vitro mechanisms of action and hormonal effects in human subjects. Much of the
evidence for a role in bone health has stemmed from animal data, as most of the available human studies are of short duration and have used either bone biomarkers or bone mineral density as end point measures. However, recent data from a long-term study suggest these compounds have a bone conserving effect in menopausal women but to accurately examine the relative importance of these compounds for bone health in postmenopausal women an assessment of consumption on fracture rates will be critical Cassidy (2003).

Scheiber et al (2001) has found that dietary inclusion of whole soy foods containing 60 mg/d of isoflavones results in significant serum levels of phytoestrogens and reductions in several key clinical risk factors for CVD and osteoporosis in normal postmenopausal women. Long-term, placebo-controlled clinical trials are needed to evaluate the effect of phytoestrogens on the clinical endpoints of CVD and osteoporosis in this population.

Fumi Hirayama et al (2009) reported that soy consumption was positively correlated with observed lung function measures. The mean soy intake was significantly higher among controls (59.98, SD 50.23 g/day) than cases (44.84, SD 28.5 g/day). A significant reduction in COPD risk was evident for highest versus lowest quartile of daily intake of total soybean products, with adjusted odds ratio (OR) 0.392, 95% CI 0.194–0.793, p for trend 0.001. Similar decreases in COPD risk were associated with frequent and higher intake of soy foods such as tofu and bean sprouts, whereas respiratory symptoms were inversely associated with high consumption of soy foods, especially for breathlessness (OR 0.989, 95% CI 0.982–0.996. Increasing soy consumption was associated with a decreased risk of COPD and breathlessness.

2.5.3 Micronutrient fortification

Efficacy studies indicated that daily consumption of 7.1 mg iron as follows sulphate, 7.1 mg iron as ferrous fumarate, 4.6 mg iron as sodium-iron
EDTA (or) 10 mg of electrolytic iron through fortified flour products will improve the iron status in women (Biebinga, 2006).

Neys Van (2008) formulated a multiple micronutrient fortified biscuits. The composition of fortified biscuit was 6 mg iron, 5.6 mg zinc, 35 mg iodine, 1.0 mg thiamine, 0.9 mg vitamin B12, 120 mg folic acid, 28 mg vitamin C and 150 mg calcium. The biscuits were highly acceptable among school children.

Brown et al (2007) formulated recently a supplement containing microencapsulated ferrous fumarate and ascorbic acid which can be sprinkled on any complementary food, it is said as sprinkles. Sprinkles are sachets contain a blend of micronutrients in powder form and it can be added in home itself which does not change the taste, colour or texture of the food.

Derman et al (2000) reported that blended food supplements make up an important sub group of processed cereal corn soymilk which contain 59 percent maize meal, 17 per cent soy flour 15 percent non fat milk and 5 per cent soy bean oil is fortified with 16 mg iron as ferrous fumarate and 40 mg ascorbic acid per 100 gm of dry cereal.