CHAPTER II

LITERATURE REVIEW

This chapter will explore the previous relevant research papers and reviews the relevant concepts and theories. The sources of evidence will be explored to evaluate the relationship between indoor air pollution and acute respiratory infections and respiratory symptoms.

1. Health Effects of Indoor Air Pollution

Smoke from biomass combustion produces a large number of health damaging pollutants; such as particles, carbon monoxide, nitrous oxides, sulfur oxides (more from coal), formaldehyde, carcinogens such as benzo (a) pyrene. Small particles with a diameter 10 microns (PM_{10}), and in particularly those less than 2.5 microns are able to penetrate deep into the lungs and appear to have the greatest health-damaging potential (WHO, 2004c). Where the households rely on biomass fuels for cooking and space heating, concentrations of this air pollution tend to be highest (Mishra et al., 2004) and bulk of the emissions is released into living area (Smith, 2000). High exposures to these air pollutants have been shown to cause serious health problems, such as acute respiratory infection (ARI), chronic obstructive pulmonary disease (COPD), cor pulmonale, tuberculosis, blindness and lung cancer and also pregnancy-related problems, such as still birth and low-weight baby (Mishra, 2004).

Air pollution has been documented to be associated with wide variety of adverse health impact in children. These include increase in acute respiratory disease morbidity, aggravation of asthma, increased prevalence of symptoms in children and lowered lung function when pollutant increases. The level of risk posed by air pollution depends on several factors, including the amount of pollution in the air, the amount of air we breathe in a given time. Young children are at high risk to air pollution than adults because they breathe more air; relative to their body weights and their respiratory system are not fully developed (Nikie, 1999).

The mechanisms by which smoke from solid fuel combustion causes ill health are only partially understood. Studies of Zelikoff, 1994: Thomas &Zelikoff, 1999;Wang &Hu, 1992, Jakab, Low, & Davis: Taszkowski & Dwornick, 1992 (as cited in Mishra, 2004) states that exposures to biomass smoke is associated with compromised pulmonary immune defense mechanisms in both animals and humans.

Air pollution might also increase the severity of respiratory infections by causing inflammation of the lung airways and alveoli. There is sufficient evidence to conclude that exposure to toxicological properties of these mixtures of woodsmoke, particularly for children, increase the risk of health hazard (Zelikoff et al., 2002).

Smith et al. (2000) states that one mechanism by which biomass smoke exposures could enhance the risk of ARI in young children would be by in utero exposures via their mothers who, when cooking, can be heavily exposed.

Smith (2000) states that number of studies done in developing countries (South Africa, Zimbabwe, Nigeria, Tanzania, Gambia, Brazil, India, Argentina and Nepal), although none of these studies had the resources to measure the level of pollution but as a group they make strong statement that exposures to biomass smoke,increases risk of ARI. However a study done in Kenya (Ezzati et al., 2001) showed that increased exposure to indoor PM_{10} increases the frequency of acute respiratory infections.

2. The Multiple Exposures Multiple Effects (MEME) Model

The Multiple Exposures Multiple Effects (MEME) model explains the relationship between environmental exposures and child health outcomes. Individual exposures can lead to many different health outcomes. Both exposures and health outcomes-as well as associations between them are affected by contextual conditions, such as social. economic or demographic factors. Beyond identifying these underlying driving forces for children's environmental health problems, information on socioeconomic status is important for reducing exposures. This MEME model applies to ARI in children (Figure 2) A driving force could be socioeconomic factors, leading exposure of a children living in homes using biomass fuels that, causes acute respiratory illness (Health outcome).

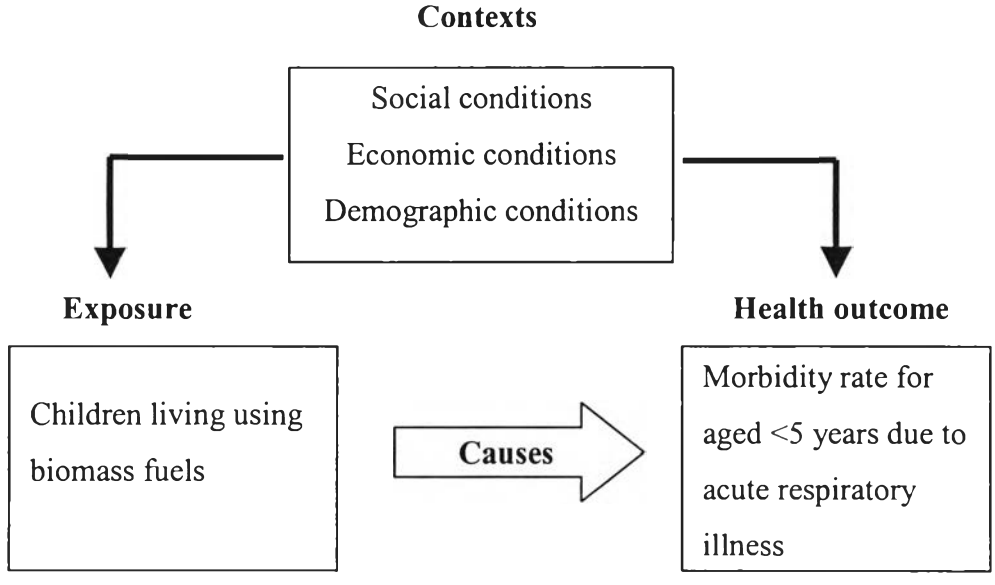

Figure 2: Multiple Exposures Multiple Effects Model, Adapted (Source: WHO, 2004a)

3. Evidence From Other Research Documents

There is consistent evidence that exposure to biomass increases the risk of common and serious disease of both children and adults. Many of the studies show that young children living in homes that burn biomass fuels have two to three times risk of developing serious respiratory infections than children who are not exposed (Mishra, 2003).

Just in the last few years, epidemiological studies have directly investigated the risks of indoor exposures in developing countries. The studies do not prove causality but only associations. Nevertheless, number of studies found similar associations in different populations, places, and times and in different mixes of cofounders and done by different investigators with different methods (Smith, 2000). There are studies, which conducted among preschool age children have observed a positive association

between exposure to biomass and ARI but some studies failed to find a relationship between biomass smoke and ARI (Mishra, 2004).

Mishra (2001) examined the effects of smoke out of cooking with use of biomass fuels on the prevalence of acute respiratory infections among young children. He studied a sample of 33,875 children under age of three from India's 1992-93 National Health Survey and found that prevalence of ARI is higher among children living in households using biomass fuels than among those living in households using cleaner cooking fuels.

A study done in Zimbabwe on 3559 children age 0-59 months found that exposure to cooking smoke from biomass combustion is significantly associated with ARI prevalence in young children. The reported prevalence of ARI was much higher among children living in biomass-fuel using households (18%) than among those living in households using low pollution fuels (10%) (Mishra, 2003). In another study of 150 infants coming to a hospital in South Africa, Kossove (1982) observed a significantly higher incidence of acute respiratory infections in children living in homes using wood-fire (as cited in Mishra, 2001).

In a study of 500 children in Gambia, girls younger than five who were carried on their mother's back during cooking were found to have a six times higher risk of acute respiratory infections (ARI) than those around parents who smoke cigarettes. But there was no significant risk for young boys, perhaps because they might be carried for shorter periods (Schwela, 1997). But in detailed analysis of data from the Gambia by

(Armstrong and Campbell, 1991) found that the risk of ARI in association with smoke exposure was increased in girls but not in boys (as cited in Smith et al., 2000).

A study of children age 3 in India, based on a national household survey, noted that both the prevalence of ARI and effect of cooking smoke on ARI were high among boys than among girls. The authors concluded this was due to strong preference of sons and discrimination against daughters, mothers in India are more likely to carry young boys than girls or keep them in the kitchen area while cooking. Due to this practice boys are exposed to smoke exposures more than girls (Mishra & Retherford, 1997).

A study conducted in Nepal, involving 240 children under 2 years old found a significant relationship between number of hours spent near the fire and the incidence of moderate and severe acute respiratory infections (Pandey et al., 1989).

Most studies conducted among older school age children fail to find a relationship between cooking smoke and respiratory problems. Azizi and Henry (1991) examined the effects of indoor environmental factors on respiratory illness among 7-12 year old (1501) school children in Kuala Lumpur and found no relationship between kerosene stove and wood stoves and respiratory illness in school children, this may be that school age/school-going children tend to spend more time outdoors. However burning of wood liberates noxious gas, which have been associated with increased occurrence of respiratory illnesses (Salam et al., 2004).

The incidence of ARI is inversely related to age. Most of children have about four to nine infections each year of first two years and drop to three to four by school age (Detels et al., 2002). Also, children under 5 years have the highest risks for acute respiratory infections since they spend much of theirs time indoor and therefore receive higher exposures than older children, who spend most of the time away from the household (Smith, 2000).

Young children with preexisting respiratory disease such as asthma, bronchitis and tuberculosis and heart disease are usually more susceptible to air pollutants (Mannino, 1999).

Stansfield and Shepard (1993) states that low socioeconomic status and crowding have been well documented as risk factors for mild respiratory infections in developed countries and studies in developing countries (Verma and Menon 1981; Stansfield 1987; Tupasi et al., 1988; Barrero et al., 1990; Vathanophas et al., 1990) have been demonstrated an increased frequency of pneumonia requiring hospitalization among from lower socioeconomic groups and in more crowded households.

Crowding often increases the risk of respiratory infection by increasing the opportunity for cross -infection among family members. The agents of such infections are readily transmitted, usually through air by droplets, in crowded and ill-ventilated rooms where people are sneezing, coughing or simply talking. Two case control studies in South America reported an association between household crowding and increased incidence of acute lower respiratory infection in young children. (Cardoso et al., 2004).

The study of Victoria, Fuchs, Flores, Fonseca and Kirkwood (1994) reported that the incidence of pneumonia increased as the number of persons in the household increased (as cited in Cardoso et al., 2004).

A study done in Uganda by Tumwesigire and Barton (1995) found significant associations between ARI and number of persons per house ($p=0.01$) and presence or absence of a smoke vent in a house ($p=0.002$).

Nikie (1999) states that respiratory symptoms were significantly more common in children exposed to parental smoking, especially cough and phlegm. The prevalence of cough and phlegm is associated with parental smoking and it is statistically significant.

Lux, Henderson and Pocock (2000) stated that there is strong evidence that cigarette smoke exposure is an important cause of wheeze and further stated that passive inhalation of smoke might have a direct inflammatory effect on airway muscusa or increase susceptibility to infection.

A study of Behera, Sood and Singhi (1989) showed that respiratory symptoms such as cold, cough and phlegm occurred more frequently in children whose households used kerosene and mixed fuels.

Although breastfeeding has long been believed to protect against acute respiratory illness in infants but studies have not constantly demonstrated that there is

protection against infection (Detals et al., 2002). However, study by Lopez-Alarcon, Villapando and Fajardo (1997) have indicated that breast-feeding protects against acute respiratory infection. Smith (2003) states that breast-feeding and vaccination for Haemophilus influenza type b (Hib) and nutrition supplements for babies and pregnant women, and case management with antibiotics have shown to be effective means to reduce mortality.