Research Journal of Chemical and Environmental Sciences
Volume 1 Issue 1 (April 2013) : 37- 41
Available Online http://www.aelsindia.com

REVIEW ARTICLE

How does Indoor Environmental Quality affect Public Health in Sustainable Urban?

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ABSTRACT

Indoor environmental quality (IEQ) has special role in human health due to the fact that most of people spend 90 percent of their time indoor, even most of social activities occur indoor nowadays. Thus IEQ has special effects on indoor social activities and consideration to IEQ can be vital for public health. Also it is obvious that appropriate IEQ happens by design, not by accident. By combining these facts, this would be concluded that designing appropriate IEQ is necessary for current and future urban living and it has raise this question: In what extend does IEQ affect public health in urban? As providing public health is a target for sustainable urban design, consideration to IEQ become an important issue provide public health.

This paper will answer this question and try to recommend new methods of designing IEQ which can improve social activities, human well-being and also public health.

Key words: *Indoor Environmental Quality (IEQ), Public Health, Social Activities, Sustainable Urban, Indoor Social Activities*

Received 27/02/2013 Accepted 30/03/2013

INTRODUCTION

Sustainable urban term consists from variety of items and contains a lot of procedures and decisions which have direct influence on human health. Also, there are lots of factors which can affect on public health; one of these factors is indoor environmental quality (IEQ). At first glimpse, it seems that there is less relation between IEQ and public health but recently, there is growing acknowledgment about this relation among urban researchers. Indeed, it is widely accepted that the indoor environmental is important for public health and that a high level of protection against adverse health effects due to inadequate IEQ should be assured. The quality of the indoor environment reflects on the health, comfort and productivity of individuals in buildings. The main reason for the lack of awareness of the problems is due to the fact that the effects of indoor air pollution are mostly chronic and long term and not directly and immediately life threatening. However, there is a growing concern about people's dissatisfaction with the air quality in their places of work. In addition, there is evidence that external environmental condition (e.g. Traffic pollution) which may be associated with indoor air quality (IAQ) and squeal such as asthma and allergies are increasing in the population. The IAQ and healthy and comfortable internal environment is the product of interaction of design, construction, use and maintenance of buildings. (Fig. 1) Causal agents of illnesses and stress in buildings may be chemical, physical, biological, psychosomatic or the synergistic effects of one or all of these agents. (Singh J. 1996)**.**

We spend more than 90 percent of our time indoors, in an environment filled with things that can produce air pollution including many consumer products, gas appliances, cigarettes and furniture, and of course ourselves. The outdoor environment, particularly the outdoors urban environment with its vehicular traffic, adds a contribution as do building materials. Over most of the world cooking and heating add a considerable contribution to the overall air pollution load in a dwelling. Because of this indoor spaces are important micro-environments when considering the impact of air pollution on health. The problem is, in fact, compounded for the indoor environment because pollution levels indoors are generally higher than those outdoors.

The importance of the problem is that the WHO has said that indoor air pollution in urban areas is responsible for about 14 times more deaths than outdoor air pollution. In total indoor air pollution is estimated to be responsible for 2.8 million deaths each year: some 5.5% of all deaths. (Hoskins J.A. 2003).

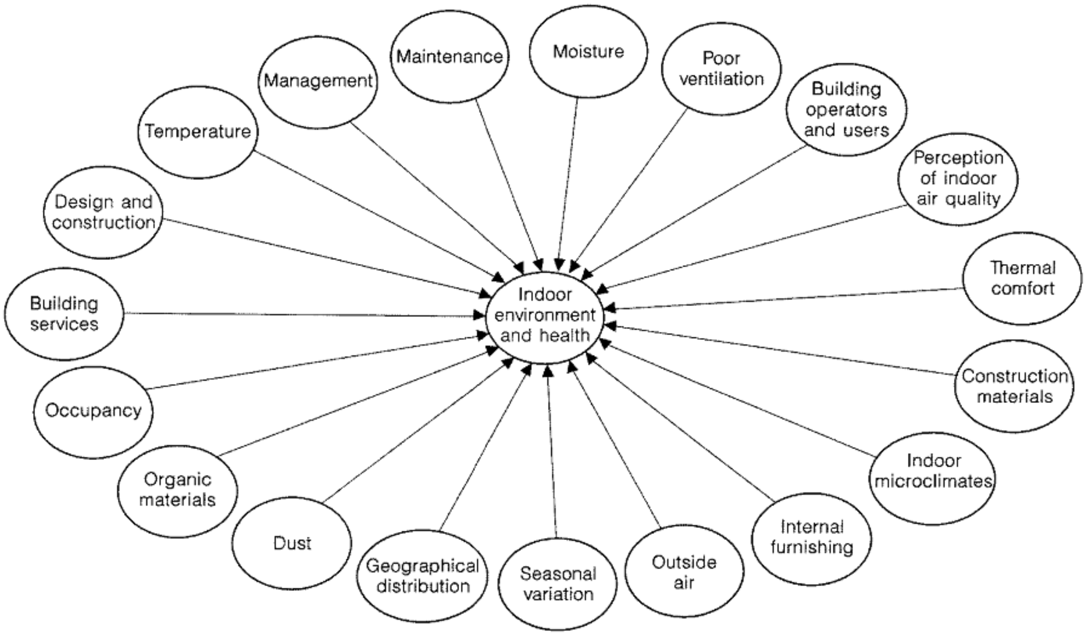

Fig 1: Factors affecting IEQ and health (Singh J. 1996)

LITERATURE REVIEW

Definition of Health

According to Weetman D. F., health's definitions are as follows:

Health is quite difficult to define precisely. According to the Shorter Oxford English Dictionary (SOED), the first use of the word was in 1509 in the context of 'good', 'bad' or The most frequently quoted definition of health is contained in the charter of the World Health Organization (WHO) as 'Health is the state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity.' The word 'complete' signifies the utopian nature of this definition. 'Social well-being' suggests the interplay of several non-medical factors, such as quality of housing, provision of a good infrastructure, freedom from war, access to health provision, and so on in achieving the WHO target of 'health for all by 2000'.This slogan implies 'the attainment by all peoples of the highest possible level of health and as a minimum that all people of all countries should have at least such a level of health that they are capable of working productively and of participating actively in the life of the community in which they live'. (Weetman, 1994) The WHO definition views health from a positive as well as a negative perspective. Although there should be an absence of disease, as envisaged in the medical model of health, there should also be factors contributing to wellbeing. Undoubtedly, something must come from medicine, but other activities are also important, which has given rise to program such as 'Healthy Cities' and the like. The WHO position on environmental health for Europe is defined in a recent publication. (Weetman, 1994)

Health and Buildings Factors

Dampness

In a large number of studies (including more than 100,000 persons) an association has been found between living or working in a "damp" building and health effects, such as cough, wheeze, allergies and asthma (Sundell, 1999; Bornehag et al., 2001). However, there are indications that also other health effects such as general symptoms (e.g., tiredness, headache, etc.), irritation and airway infections are associated with dampness Relative risks, commonly indicated by odds ratios, are similar for infants, children and adults, in homes and at workplaces, in the range of 1.4–2.2. Relative risks are in the same range regardless of the outdoor climate. From present-day scientific literature it is not possible to make a more precise health-relevant definition of a "damp" building, or to specify which agents in damp buildings are the causes of health effects. (Sundell J., 2004)

Ventilation

Ventilation system in buildings has been classically divided into two groups: one system use to exchange the air in the room and another system use to remove contaminants. The association between ventilation and health is rarely studied. A European multidisciplinary scientific review group has deemed only 30 scientific studies to be conclusive on the matter (Wargocki et al., 2002a). The scientific evidence indicates that ventilation rates (outdoor air) below 25 l/s per person in commercial and institutional buildings are associated with an increased risk of SBS, increased short-term sick leave, and reduced productivity (Sundell et al., 1993; Sundell, 1994; Wargocki et al., 2002b). Studies on the association between health effects and ventilation rates in homes are rare. However, the literature on ''dampness'', especially as regards ''condensation on window panes'', suggests that inadequate ventilation in homes constitutes a major risk factor for health effects (cough, wheeze, asthma and airway infections) (Sundell et al., 1995; Bornehag et al., 2001; Wargocki et al., 2002a). It is well established that ventilation rates in homes have been reduced during recent decades, as a result of energy conservation measures in Nordic and other western countries. This development may be associated with the increase in allergies. In former Eastern Europe, the same development is now rapidly taking place as a result of the increased cost of energy, and thus increased tightening of buildings, resulting in reduced ventilation. (Sundell J., 2004).

Building materials

Primary emissions from building materials refer to the emissions from the materials themselves. The level of these emissions is highest immediately after manufacture, and is expected to diminish radically during the first six months, and to have disappeared substantially after the first year of use. Secondary emissions denote the emission of pollutants that is caused mainly by actions on the material. Factors that affect a material may be moisture and alkali in the building structure, high surface temperatures or different treatments with chemicals such as floor cleaners, waxing, etc. Secondary emissions may increase in time and may last for a long period (Sundell J., 1999). Owing to the fact that primary emission has been the subject of greatest interest, there has been a rapid development towards ''low-emitting'' materials. This has reduced the emission of commonly measured organic compounds, mainly rather stable volatile organic compounds, from building materials. Whether this development has reduced health complaints in new buildings is not known.Today, secondary emissions are regarded as being of greater significance for health. (SundellJ., 2004)

Indoor air chemistry

Many harmless organic pollutants in indoor air react with, e.g., ozone, producing highly reactive compounds that quickly react on/with skin or mucous membranes (Sundell et al., 1993; Weschler, 2000). Many of these compounds (e.g., free radicals) are not easily measured, but may be far more relevant from a health point of view than their precursors.This indoor air chemistry occurs in the air, but also on room surfaces. Humidity, ventilation rate, PVC, wood, cleaning agents, air fresheners, etc. must be viewed in a new light. (Sundell, 2004).

Health and Sustainable Design

Sustainable design is a collective process whereby the built environment achieves new levels of ecological balance in new and retrofit construction, towards the long term viability and humanization of architecture. Focusing on environmental context, sustainable design merges the natural, minimum resource conditioning solutions of the past (daylight, solar heat and natural ventilation) with the innovative technologies of the present, into an integrated "intelligent" system that supports individual control with expert negotiation for environmental quality and resource consciousness. (Loftness et al 2005).

Sustainable design rediscovers the social, environmental and technical values of pedestrian, mixed-use communities, fully using existing infrastructures, including "main streets" and small town planning principles, and recapturing indoor-outdoor relationships. Sustainable design avoids the further thinning out of land use, and the dislocated placement of buildings and functions caused by single use zoning. Sustainable design introduces benign, non- polluting materials and assemblies with lower embodied and operating energy requirements, and higher durability and recyclability. Finally, sustainable design offers architecture of long term value through 'forgiving' and modifiable building systems, through life-cycle instead of least-cost investments, and through timeless delight and craftsmanship. (Loftness et al 2005).The importance of proving that sustainable design and engineering improves health, productivity, and quality of life has never been more important. To this end, the Center for Building Performance at Carnegie Mellon University in collaboration with the Advanced Building Systems Integration Consortium (ABSIC 2000-present), have been actively developing a building investment decision support tool BIDST. This cost benefit tool presents the life cycle data of over 200 case studies, laboratory, field, and simulation studies that reveal the substantial environmental benefits of a range of advanced and innovative building systems. This presentation will explore the health related benefits of high performance buildings - designed to deliver the highest quality air, thermal control, light, ergonomics, privacy and interaction, as well as access to the natural environment. (Loftness et al 2005).

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Public Health and Indoor Environmental Quality (IEQ)

Indoor home environments are the sites of a variety of biological, chemical, and other environmental hazards. Biological hazards include infectious agents such as bacteria and viruses, molds, endotoxins and antigens from house dust mites, rodents, cockroaches, pollen, and animal dander. The allergenic constituents of indoor air are predominantly biologic in origin. In recent years, the dramatically increasing rate of asthma in modern societies, coupled with the growing concern regarding indoor environments, has prompted a number of studies concerning exposure to airborne biologic agents and asthma [Institute of Medicine (IOM) 2000].

Indoor environmental quality affects individuals' thermal, olfactory, or sensory comfort; health; and work performance. A broad range of health effects may result from exposure to indoor pollutants. Some pollutants (e.g., radon, environmental tobacco smoke [ETS], formaldehyde, benzene, and perchlorethylene) increase the risk of cancers or of other very serious health effects. Some indoor pollutants can cause infectious diseases such Legionnaires' disease, the common cold, and influenza. Allergy or asthma symptoms may result from exposure to indoor pollutants, especially biological contaminants such as mold and plant or pest allergens. Finally, indoor pollutants may contribute to irritation of the eye, nose, throat, or skin; coughing; wheezing; headache; and fatigue, symptoms that are often called sick building syndrome (SBS) symptoms or building-related symptoms (BRS).(Muddari, 2010).

Just as indoor conditions affect people's health and comfort, indoor exposures also affect their performance and productivity. The ability to perform mental and physical tasks, rates of absenteeism, performance at school, and productivity at work have all been associated with indoor environmental quality. (Muddari, 2010).

Figure 2 illustrates the complexity of the relationship between the indoor structure, the hazards generated as a consequence, and the ultimate health effects in the population. Characteristics of the building structure, such as its composition, contents, and building systems, as well as attributes of the population and activities within the building, all contribute to the health of the indoor environment. Ultimately this can lead to a variety of adverse health effects including respiratory, neurologic and dermatologic, among others, as shown in Figure 2. (Wu F. et al 2007).

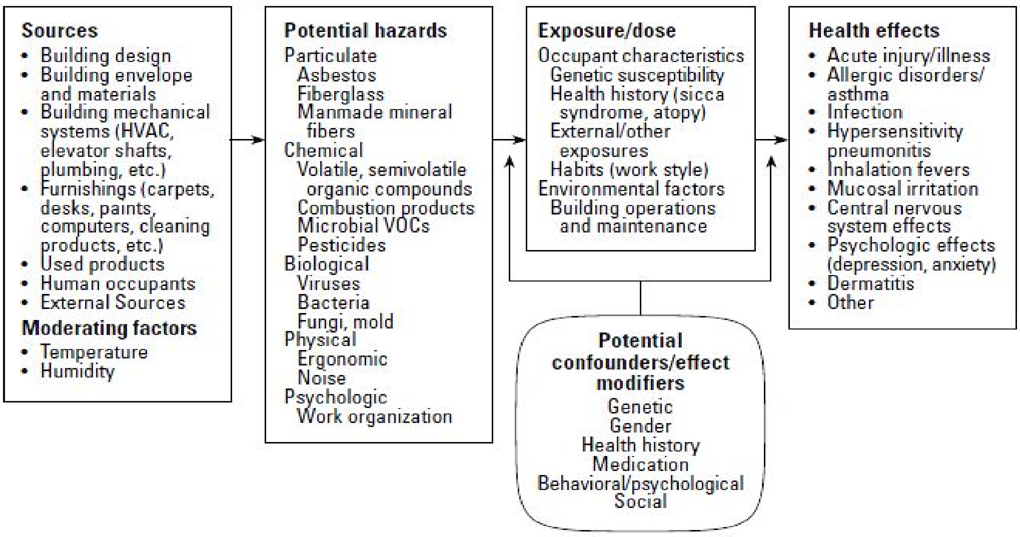

Fig 2. Relation of IEQ and Health effects. (Wu F. et al 2007)

Public Health and Indoor Air Quality (IAQ)

This broad classification scheme makes clear the potential scope of the public health problem posed by indoor air pollution and the difficulty of fully estimating the magnitudes of adverse.

Within this schema, some adverse effects have clear definitions (e.g., death from carbon monoxide poisoning) while others are defined on the basis of subjective responses, and any criteria for placing responses into a particular category require the assumption of a societal framework for separating adverse from non adverse responses. Risk assessment has been used to quantify the hazard associated with some carcinogens of current concern and a few exposures associated with non-malignant respiratory effects. However, symptom and perceptual responses to indoor air pollutants can only be addressed by directly investigating exposed populations. To date, few studies have addressed these responses in population- based samples, and we thus lack any comprehensive and population-based assessment of the full scope of the public health consequences of indoor air pollution (Samet 1993). We also lack societal guidelines for describing the magnitude of the problem. In the United States, for example, public policy has evolved for single pollutants without broader consideration of more fundamental principles. Even for single agents, e.g., radon, conflicting views among involved regulators, the Congress, and scientists have led to persistent controversy (Cole, 1993). Without any firm guidelines, the scope of the problem of indoor air pollution can be readily manipulated, as underlying assumptions in risk assessments are varied. A process is needed for establishing a conceptual framework for indoor air pollution (Nero, 1993; Spengler and Samet, 1991).

Would the goal of public health protection be better achieved by more complete information?On the health effects of indoor air pollution? My answer to this question is affirmative. The emergence of indoor air pollution as a unified public health concern has fostered the interdisciplinary interactions that are needed to find solutions. If the consequences of indoor Pollution exposures are fragmented into a series of seemingly unrelated problems (e.g., combustion products, hypersensitivity pneumonitis, comfort, and radon), the imperative to achieve solutions through actions needing coordination of a wide range of professionals and organizations is diminished. More information on the public health burden posed by indoor air pollution is central to maintaining research on sources, exposures, health effects, and control measures. (Samet, 1993).

Infants and children are at much higher risk of exposure to environmental stressors and toxicants because, pound for pound, they inhale twice as much air at rest, eat 3–4 times as much food, drink 4 times as much as water, and have 3 times the rate of skin absorption compared with adults (Bearer 1995). The total annual cost for environmentally attributable childhood diseases in the United States from lead poisoning, asthma, and cancer alone is US$54.9 billion (Landrigan et al. 2002). Although not all of this is due to indoor exposures, their contribution is significant. (Wu et al 2007).

Because indoor environmental contaminants are significant public health risks, particularly among children and the poor, both the adverse health effects and exposure levels deserve public policy attention, as the costs to society associated with illnesses related to indoor environments are considerable. (Wu F. et al 2007).

Conclusion

As indicated in this paper, indoor environments are unique and contain significant exposures that can affect the health of occupants; also as people spend more time indoors, the opportunities increase for significant health effects resulting from these exposures. Thus, by improving IEQ the occupant health and then the public health will be improved. Indoor environment factors are responsible for much morbidity and mortality in the world. Fortunately, new techniques for measuring health effects of IEQ in an objective way are being developed, and will facilitate the evaluation of indoor environment problems. These techniques should be used in every building to improve human well-being and health.

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