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THE IMPACT OF HOUSING INDOOR CLIMATE ON THE HEALTH OF THE ELDERLY

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1. INTRODUCTION

There has been increasing concern on the part of many people of the effect of the indoor microclimate on the health of the occupants, particularly upon elderly people. This concern is based upon many conditions, but largely it has been triggered in several nations through attempts to conserve energy by making dwellings more air-tight and by reducing the ambient air temperature inside the dwellings. Recent studies[1,2] have identified potentially harmful contaminants in significant concentrations in the air of some dwellings such as formaldehyde from plywood, particle board, and foam insulation, radon for soil or building materials and fibers of asbestos from fire-proofing.

Another factor contributing to the increasing concern of the effects of the indoor microclimate on the health of the elderly is the recognition in many nations that the percentage of the population who are elderly is increasing steadily. Elderly persons tend to spend more time inside their dwellings than younger persons and, if the environment of the dwelling contains hazardous or unhealthful conditions, these older persons may suffer more from them than do younger persons.

Also, it is a well established fact that the elderly have less tolerance

to extremes of temperature.[3] Physiologically, they can not adapt to cold or hot environments as easily as younger persons. The body heat regulatory functions of older persons are less efficient and these persons can suffer from hypothermia or hyperthermia under conditions that are tolerated by those who are junior to them in age.

2. THE MICROCLIMATE OF DWELLINGS

2.1 The Health Effects of Housing on Occupants

Previous reports [4] have identified some of the ways which specific conditions of housing may affect the health and well-being of the occupants. In general, these mechanisms are as follows:

(1) may not fulfill physiological needs of the occupants;

(2) may promote the disemination and transmission of disease agents;

(3) may cause accidental injury; and

(4) may adversely affect mental well-being.

These mechanisms were identified in considerable detail as early as 1939 by the Committee on the Hygiene of Housing of the American Public Health Association[5] under the chairmanship of Professor C.-E.A. Winslow, who at that time was an active member of the Housing Commission, Health Organization of the League of Nations. The Housing Commission, in one of its early reports[6] defined a need to initially study and evaluate the "hygiene of the environmental conditions in dwellings (temperature, purity, humidity, movement of air and temperature of the surroundings)" and subsequently to research other aspects of housing which may affect health.

As defined by the Housing Commission, a synonym for the "hygiene of the environmental conditions in dwellings" is indoor microclimate. There are many

parameters which determine the microclimate of dwellings, however, the principal ones may be enumerated as the temperature of its walls and surroundings and the temperature, moisture, air movement, and exchange of air within it.[7]

The fulfillment of the physiological needs of the occupants of a dwelling involves not only the parameters of the microclimate of a residential structure as defined above, but also the quality of air. Pollutants in air interior of dwellings include these which are generated outdoors and those which are released from indoor sources.

2.2 Thermal Aspects of the Microclimate of Dwellings

The principal environmental factors influencing the thermal quality of air in dwellings are:

(a) the dry-bulb or ambient temperature of air;

(b) the mean radiant temperature of the surroundings including walls, floors, ceiling or roof, windows, heating appliances and human bodies;

(c) the humidity or moisture content of air;

(d) the movement of air.

An imbalance of these factors may lead not only to discomfort, but also to disturbing the body's heat-regulating mechanisms and equilibrium thereby causing pathological conditions. Also, they may contribute to the causation of infections and of accidental injuries.

During the past several decades, much research has been conducted on thermal comfort. These studies suggest that under carefully controlled conditions the preferred ambient air temperature is reasonably uniform for all persons regardless of age, sex, acclimation, race, physical fitness and other personal factors.[8] Other studies have examined physiological responses aimed at keeping the body temperature at a constant value.[9] These researches have noted that when the body temperature falls, the skin temperature tends to fall first, and then very gradually, the deep body temperature falls.

In situations in which the human body is losing or gaining heat to or from the environment, the first physiological response is a change in blood flow to the extremities and to the skin in general. If the body is losing heat to the environment and if the reduction of blood flow to the extremities and to the skin in general does not stem the reduction in body temperature, involuntary shivering commences which causes an increase in metabolic heat production. If the body is gaining heat, increased body temperature causes the secretion of sweat over most of the body and cooling of the skin may occur, the degree of cooling being dependent upon such factors as relative humidity and movement of air around the body.

Body heat loss may be modified to a degree by the insulation provided by clothing. Thermal comfort for approximately 80% of the population exists within the range of indoor ambient air temperature of 18°C. to 30°C. or within the range of indoor operative temperatures of 16°C. to 32°C.[27] At the lower temperature values, to obtain thermal comfort, individuals must wear substantial clothing and at the upper temperatures, minimal clothing is required.

If the deep body temperature falls below 35°C a state of hypothermia exists and there is an increased risk to the health and well-being of the individual. Similarly, if the deep body temperature rises above 39°C, a state of hyperthermia exists which is also an unhealthful condition.

In most nations located in the temperature zones, hypothermia, particularly among the elderly is a serious health problem. Studies in Great Britian in 1972 showed that 0.5% of elderly persons over 65 years of age had deep body tempdratures which denoted hypothermia and that between 5 and 10% were in a borderline condition.[10]

Hypothermia occurs more frequently among the elderly because of reduced efficiency in the thermoregulatory process. Persons in the upper decades of life are less able to compensate for loss of body heat than younger persons. The First Report of the Expert Committee on the Public Health Aspects of Housing published by the World Health Organization in 1961[4] recommended that the ambient

air temperature in dwellings occupied by elderly persons be 2°-3°C (5°F) warmer than dwellings occupied by younger persons. Further, this Committee recommended more uniform distribution of the heated air from floor to ceiling to avoid chilling of the lower extremities.

If the deep body temperature exceeds 39°C, a state of hyperthermia exists which may manifest itself in one of several ways, the more serious of which are heat stroke and heat hyperpyrexia. Heat stroke is a disorder of the thermoregulation processes and is characterized by an absence of sweating and an elevated deep body temperature. The onset of symptoms is usually sudden and the reported mortality ranges from 17-19%.[11] The higher mortality rates are often associated with advanced age. Heat hyperpyrexia is a milder form of heat stroke in which there may be some sweating and usually involves less severe brain disorders.

Heat stroke with accompanying high mortality rates have been observed on some localities from time to time when unusually high ambient air temperatures are reached. Oeschsli and Buechley[12] studied the excess mortality rates in the Los Angeles, California area of heat waves which occurred in 1939, 1955, and 1963, and noted some unusual characteristics. In the 1939 and 1955, total mortality following a day with a maximum ambient temperature of 43°C (110°F) was 160% greater than expected. The mortality in the 50-54 year age group was 307% greater and the mortality for those over 85 years of age was 810% greater than expected. Since the over 85 years of age group was small, the excess mortality rates for this group may have been subjected to greater random variation than other age groups. The relationships cited above were not observed during the 1963 heat wave which was similar to the ones in 1939 and 1955. The excess mortality, while elevated in 1963 was considerably less than in 1939 and 1955. Oeschsli and Buechley tentatively attributed this finding to the increased use of air conditioning in dwellings in the Los Angeles area. Other investigators [13,14,15]

have noted similar increased mortality among the over 65 year age group associated with heat waves.

A fatal episode of hyperpyrexia which occurred in August 1976 involving a nursing home for elderly and chronically ill residents located in southeastern Florida, U.S.A., has been reported.[16] During a 5-day period of time when the outdoor maximum air temperature ranged from 31.1°C to 32.2°C and the maximum relative humidity rates ranged from 85% to 99%, the air conditioning apparatus serving the nursing home with 89 residents failed. 21 residents developed hyperpyrexia of which 5 died. Subsequent studies of those residents who expired indicated that all succumbed to hyperpyrexia.

2.3 Humidity of the Air in Dwellings

Comfort and tolerance to extremes of temperature are affected greatly by the humidity of the air in dwellings. A high relative humidity, particularly with an elevated ambient air temperature, may adversely affect the thermal balance of the body by reducing the evaporation of perspiration and thus slowing the loss of body heat. On the other hand, a very low relative humidity increases the rate of evaporation of moisture from the mucous membranes of the respiratory system and may give rise to unpleasant sensations. Also, air with low relative humidity impairs the filtering action of air-borne particles in the upper respiratory passages.

Studies have indicated that indoor relative humidities between 20% and 70% are comparable with health[1]. The preferred humidities tend to be between 40% and 50%. Goromosov recommends that, from the standpoint of health, the relative humidity should not be lower than 30% or greater than 60%.[7]

Relative humidities near the 50% range tend to be more lethal to many air-borne microorganisms than lesser or greater values.[17] This phenomenon has been explained by decay rates of aerosols containing the microorganisms.

Low relative humidities, e.g. < 20%, and high relative humidities, e.g. > 90%, hastens the decay rate for most aerosols with an optimal humidity values ranging from 40% to 60%.[18]

2.4 Movement of Air in Dwellings

Movement of air in dwellings is usually influenced by two basic factors, namely infiltration and ventilation. Infiltration is the movement of air through cracks around doors and windows, through cracks and crevices in walls and through chimneys and fireplaces. It is caused by the pressure exerted by wind and by the difference in density of outside and inside air due to difference in temperatures. Ventilation may be considered to be the intentional movement of air in and/or through an enclosed space. Usually it implies that cleaner air will be introduced into a room while simultaneously the more polluted, fouled and/or contaminated air is removed. Ventilation may occur as the results of natural forces or it may be mechanically induced.

Infiltration of air into dwellings is sometimes referred to as "leakage" - implying the "leaking" of exterior air into the interior. If the exterior air is of better quality than the interior air, infiltration will reduce the contaminant level of the interior air, however if the opposite condition exists, the quality of the air interior of the dwelling will be deteriorated by infiltration.

Special attention has been given to infiltration of air into dwellings during the past decade as infiltration may affect the thermal conditions of the living space. As an energy conservation measure, active steps have been and are being taken in many nations to reduce infiltration of air into dwellings during the heating months. It has been reported[2] in the United States of America that approximately 50% to 60% of the energy used to achieve "comfortable" or an "acceptable" thermal quality is consumed by infiltration and ventilation.