Adapting IESD-Fiala model to the aging population

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Like it or not, the simple truth is that we are all growing older, and eventually, old. Research into thermal comfort of the aged may become relevant to ourselves much sooner than one would expect.

Growing old

Many changes happen as the body ages. Most visibly is the change of body shape. Typically, a person may lose 1cm of height per decade after age 40. The rate accelerates after age 70. This is combined with accumulation of body fat by as much as 30%, especially towards to centre part of the body, e.g. around the abdominal organs. Body weight peaks at age 55 for men and age 65 for women. The legs and arms may appear "bony" whereas skin becomes dry and less elastic due to the loss of muscle mass and body water content.

Deep within, the body's basal metabolism decreases significantly, in conjunction with weakening of the cardiovascular system, loss of muscle mass, and degeneration of neural functions. Although other common problems such as osteoporosis and stiffening of joints may have little bearing on the thermal properties of the body, the reduction of mobility and the change of appearance may have significant psychological impact that inevitably affect social involvement and behaviour.

Thermal comfort implications

The thermal comfort issues with the older population are potentially more critical than that with the younger (e.g. working) population, in the sense that it has a direct impact on the health and wellbeing of the individuals. In extreme cases, poor thermal comfort may contribute to excess mortality in the most vulnerable group.

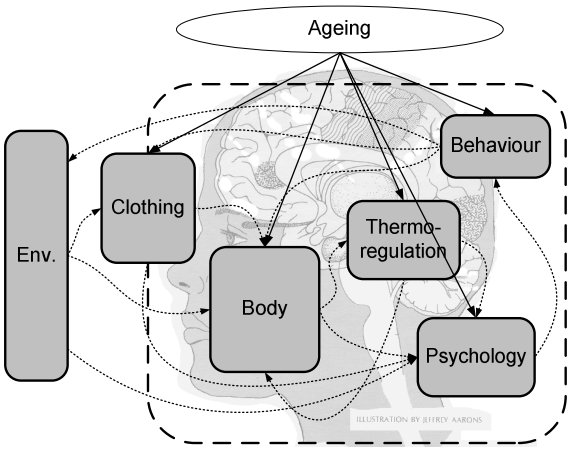

Figure 1. Evaluation of thermal environment

Then what are the implications of the aging effects on the thermal comfort requirement? In a nutshell, aging means the reduction of adaptation capacity to the environments, which manifests in both cold and over heating situations. As van Someren (2007) summarised, the degenerative effects of ageing on thermoregulatory mechanisms can be explained by "less reserve in elderly persons" caused by decreased capacity to regulate efficiently pulse rate, blood pressure, and oxygen use etc. Also, decreasing vasomotor responsiveness to norepinephrine subsequently makes vasoconstriction and shivering less effective, which may partially explain heightened discomfort in cooler condition for elderly persons.

Figure 1 illustrates the complex impact of aging on thermal comfort, where non-physical/physiological factors including choice of clothing and psychological / behavioural changes are also considered. The components in the diagram are interconnected and interactive. Multiple feedback routes are present. The best approach to study the aging effects is to use an integral human model.

Adapting Fiala model

Developed in the 1990s, the IESD-Fiala model inherited the majority of concepts of the earlier models proposed by Stolwijk (1966, 1971) and Gagge (1973). The heat transfer process in the human body and the thermoregulatory responses were modelled to maintain a balance between heat gains and loss. The Fiala model claimed to represent an "average man" (body weight 73.5kg; body fat 14wt-%; Dubois area 1.86m^2; basal metabolism 87W; basal cardiac output 4.9l/min). The first step to adapt the Fiala model for evaluating thermal comfort for the older population is to model an "average older person" from the statistical data. In this paper, the model sensitivity to these parameters is presented.

The next step is to correlate the predicted physical and physiological parameters of an aged body to the thermal comfort assessment. Existing thermal comfort indices and models are based on data collected from field surveys or controlled experiments. Unfortunately, most of the surveys and experiments focused on working population. Very few thermal comfort data for the 65+ yr group are available.

Availability of knowledge and data

Vast body of scientific research in the areas of human biology, psychology and sociology relating to aging are available. Application of these knowledge and research findings in designing better facilities for the older population is not always straightforward. Using a modelling approach, especially on the basis of the existing IESD-Fiala model, may help bring our understanding of aging to the design practice. The work is currently on-going at the IESD. The challenge, however, is to assimilate knowledge and real world data from all possible sources, which again requires joint efforts and collaborations.