Impacts of the thermal environment and indoor air quality on potential risks for elderly people with cardio-vascular diseases

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Introduction

In the REHVA Journal Vol. 50, Issue no. 3, the problems of suitable indoor environment conditions for elderly people were discussed (van Hoff and Westerlaken, 2013). Present study prolong these theme with presentation of in-situ analyze of physiological response of elderly people with and without cardio-vascular disease. Simultaneous influence of indoor thermal comfort and indoor air quality conditions on response of the cardio-vascular system during summer time including two heat wave periods was studied and presented.

Importance of indoor comfort for elderly people

With ageing, human ability to thermo-regulate the body temperature tends to decrease. This multi-factorial process involves many of human physiological systems and could be clearly identified thought the response of the cardiovascular system. Among several parameters, increase of heart rate and a decrease of blood pressure are most indicative risk factor for cardiovascular morbidity and mortality (Fox et al., 2007). High heart rate is considered to promote atherosclerosis, meanwhile excessively low mean arterial pressure can indicate serious heart or neurological disorders. Not only inappropriate indoor thermal comfort (*ITC*), low indoor air quality (*IAQ*) as well affects human health and results in even more extensive cardiovascular system response. The aim of the article is to present the research on combine influence of *ITC* and *IAQ* conditions on physiological response of the elderly people and to show that physiological response is even more intensive in case of elderly people with cardio-vascular diseases (CVD).

Real environmental experiment of elderly's physiological response to ITC and IAQ

Research was focused on the determination of combine impacts of *ITC* and *IAQ* conditions on the cardiovascular system response of the elderly people in elderly home in Ljubljana. The building itself has no mechanical ventilation, nor air conditioning as it is still very common practice in Slovenia. Two groups of people older than 65 years were studied at the same time: a group of 27 persons (46% male, 54% female) without CVD called control group and group of 50 people (48% male, 52% female) with CVD diagnose in accordance with the International Classification of Diseases. The research was conducted for 80 days from June to September 2011. In the period of research two heat waves occurred: the first one between July 7th and 14th and the other between August 17th and 26th, which was even more pronounced. During the experiment which was performed as natural experiment without controlling the indoor parameters, indoor air temperature (T) and indoor relative humidity (RH) and CO_2 concentration was measured during the daily observation period (between 11:00 and 15:00 o'clock). The Humidex index (HI) was used to combine effect of air temperature and humidity. HI describe perceived environment temperature (for example at T=30°C and RH =40% HI is equal to 34 and at the same temperature and RH=60% HI is equal to 38) and is similar to U.S. Heat index. Analysis of physiological response was focused on individual's relative change of the heart rate (ΔHR) and change of the mean arterial pressure (ΔMAP).

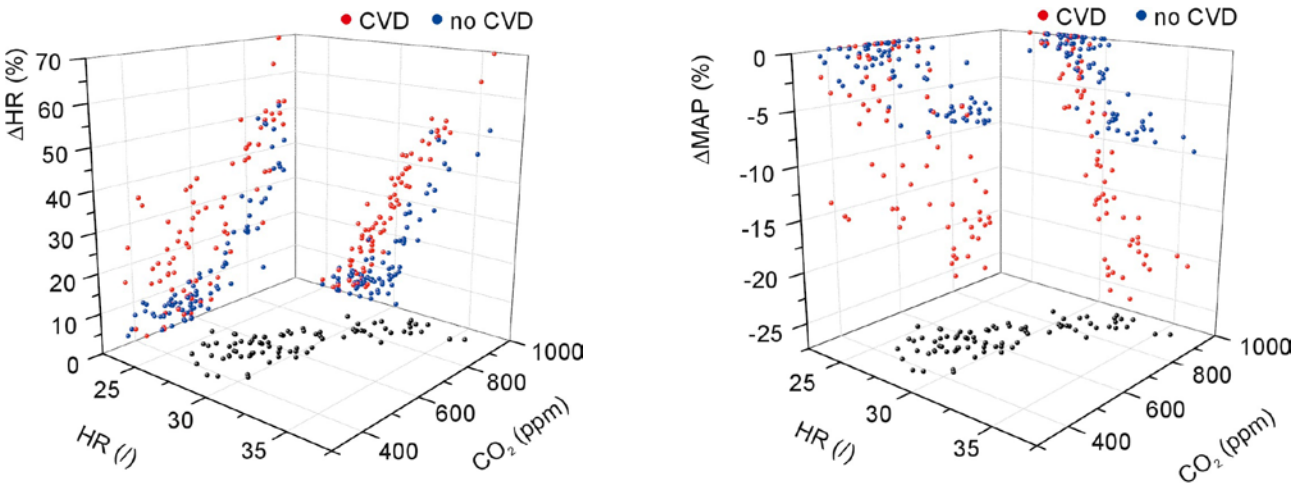

Figure 1. Physiological response of the group of elderly people without and with cardio-vascular diseases (CVD) to Humidex HI (combine indicator of temperature and humidity) and CO_2 concentration in indoor environment presented as group's average daily value of relative change in heart rate (ΔHR) and mean arterial pressure (ΔMAP) during the observed summer period.

Reference values (ΔHR=0 and ΔMAP=0) were defined separately for each of the group as average value of *HR* and *MAP* in none stress conditions (it was found out that this conditions corresponds to $T < 25$°C and CO_2 <500 ppm). Results are presented on Figure 1 as average values for each day of during the research.

Results

During the research period no adaptations of physiological parameters were found in any group, but significant differences between groups with CVD and no CVD is obvious. During both heat waves lower *IAQ* (higher CO_2 concentration) appeared due to the fact that residents are closing the windows to prevent over heating the rooms. Group with CVD responses to the *ITC* and deteriorated *IAQ* much more intense than control group therefore elderly people with CVD are at considerable higher risk for mortality events. We found significant combined effects of *ITC* and *IAQ* on cardio-vascular parameters although increase in ΔHR due to heat burden and low indoor air quality in case of people with CVD was significantly higher. For this group increase of ΔHR up to 70% can be seen, meanwhile in group with no CVD the ΔHR up to 50% was found (**Figure 1**). Respectively decrease in ΔMAP as consequence of vasodilatation in both groups can also be observed. In particular, *HI* has significant impacts on physiological parameters, although CO_2 as indicator of *IAQ* has also noticeable effects on human response (Figure 1). Since it is known that elevated *HR* and low *MAP* are risks factors for cardio-vascular morbidity, such populations are also at higher risk for mortality events.

Conclusion

Risk groups, like elderly people with chronically diseases, are at greater threats as thermo regulation is direct depended on cardiovascular response. It was found out that group with CVD respond to *ITC* and *IAQ* significantly more intensively than control group. Nevertheless our research also show that not only heat burden, but combined influence of the indoor air quality have to be taken into the account when assessment of indoor comfort is made. Planners and decision makers that work in the field of designing indoor environment for elderly people or other risk groups should be aware of joint influence of the thermal environment and the air quality on health and that unsuitability conditions could be ascertain by the occupancies physiological response. ■

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