Popular Science Summary

There is strong evidence that climate change has a direct impact on humans and extreme temperatures have been linked to negative human health impacts. The heat wave of 2018 caused in Sweden up to 8.2% more deaths compared to the year before. In Sweden, future climate projections estimate a temperature increase with up 3-5°C by the 2080's, creating a greater risk for humans to be exposed to higher temperatures compared to the past climate. Further, energy efficient buildings can increase the indoor temperatures, mainly because of lower air exchange rate between indoors and outdoors, which is one method to minimize the heat losses through the building envelope. Because people spent almost 90% of their times indoors, the indoor environment is more susceptible to increase the health impacts on humans due to future indoor temperature exposure. This study analyzed the impacts of future climate on indoor thermal comfort and assessed how the human health is affected due to future indoor and outdoor temperature exposure. Future climate projections were used to simulate the indoor temperatures and energy demand of three different constructions of the same building type; original building, retrofit and new design. This was done for three different locations in Sweden; Malmö, Stockholm and Umeå. The effect on human health was estimated with the use of temperature-related morbidity and mortality calculations, with the variation of two different human age groups. Results showed that the implementation of energy efficient measures for the retrofit and new designed building reduces the heating demand with up to 60% compared to the original building. Projections of the indoor temperatures indicated the highest risk of overheating (hours over 26°C) in the original construction of the building, followed by the new design and lowest overheating risk in the retrofit building. Malmö, located in the south of Sweden, is more susceptible for overheating potential compared to Stockholm and Umeå. For all cases, elderly people are of higher risk to experience thermal discomfort indoors. Indoor comfort simulations showed that elderly experience on average 10-12% more discomfort hours compared to people aged 0-65 living in the three considered cities. Projections of the health impact due to temperature exposure of the future climate conditions showed likewise highest risk for elderly people with higher grade of risk in Malmö compared to Stockholm and Umeå. But in contrast to the findings of indoor comfort analysis, the health impact assessment due to indoor temperature exposure indicated highest risk for people living in the new designed building, where indoor temperature reaches up to 34.4°C. Although projections of indoor environment in the original building indicated higher numbers of overheating, the indoor temperature is higher in the new designed building, with more frequent occurring extremes. Results of this study showed that the future heating demand can be reduced with up to 60% under future climate projections and the implementation of energy efficient measures, following the Swedish national goal to reduce the carbon footprint of the building stock. However, results also showed that the transformation of the building stock can increase the human health impact due to temperature-exposure because of the implementation of energy-efficient measures in the new construction. Therefore, it is important to account for the impacts of climate change on humans and their health when constructing new buildings. The design should decrease the energy demand, without compromising the thermal comfort and thus increase the risk for humans.