

Are women feeling colder than men in air-conditioning buildings?

Recently the international media like in USA, Canada, UK, Denmark, Germany etc. has been discussing the issue of differences between men and women regarding thermal comfort and the preferred room temperature. This presentation will discuss the issue of thermal comfort and the existing knowledge on the influence of gender.

Results

The Dutch study

In their paper, researchers Boris Kingma and Wouter van Marken Lichtenbelt (2015) state, “Indoor climate regulations are based on an empirical thermal comfort model that was developed in the 1960s. Standard values for one of its primary variables—metabolic rate—are based on an average male, and may overestimate female metabolic rate by up to 35 percent”. According to their experiment with 16 females performing sedentary work, they measured a significant lower metabolic rate for women than the metabolic rate for a “standard man”, which they found in literature. This will, according to the authors, result in a higher preferred room temperature for women.

The existing literature

Fanger (1982), Fanger and Langkilde (1975), and Nevins et al. (1966) used equal numbers of male and female subjects, so comfort conditions for the two sexes can be compared. The experiments show that men and women prefer almost the same thermal environments. Women’s skin temperature and evaporative loss are slightly lower than those for men, and this balances the somewhat lower metabolism of women. The reason that women often prefer higher ambient temperatures than men may be partly explained by the lighter clothing normally worn by women.

Looking at the existing literature (Karjalainen 2011) clearly more than half of the laboratory and field studies have found that females express more dissatisfaction than males in the same thermal environments. A Meta-analysis shows that females are more likely than males to express thermal dissatisfaction (ratio: 1.74, 95% confidence interval: 1.61–1.89). Females are more sensitive than males to a



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Study	Sex	Preferred ambient temp. (°C)	Mean skin temp. at comfort (°C)	Evaporative weight loss during comfort (g/m ² /hr)	Number of subjects
Nevins et al. 1966 Fanger 1982 (both studies combined)	Males	25.4			488
	Females	25.8			488
Fanger & Langkilde 1975	Males	25.0	33.6	19.5	32
	Females	25.1	33.4	16.6	32
Comfort equation Fanger 1982		25.6			

Subjects were tested under the following standardized conditions: sedentary activity: light clothing 0.6 clo, rel. velocity <0.1 m/s, rel. humidity 50%, mean radiant temperature = air temperature.

Figure. Preferred ambient temperatures (air ~operative temperature) in laboratory test with the same sedentary activity level (1-1.1 met) and the same clothing (~0.6 clo) for all subjects.

deviation from an optimal temperature and express more dissatisfaction, especially in cooler conditions.

However, most studies found no significant difference in neutral temperatures between the genders as also shown in the basic studies in the table.

The existing standards

Existing international standards like ISO EN7730, EN15251 and ASHRAE 55 are based on the same basic studies described above. These standards do not specify different room temperatures for women and men when doing the same work and dressed in similar clothing.

Contrary to what has been suggested, these standards are not devised exclusively for men. They are based on extensive laboratory studies of both men and women

wearing the same clothing, engaged in the same activity, and exposed to a wide variety of thermal conditions (air temperature, surface temperature, humidity and air movement). Metabolic heat production was simply a proxy for the kind of activity. And while it is one of many variables used in an empirical formula, it is not an input to a heat balance equation, as one might find in a thermo-physiological model (which exists, but was not the basis for the standards)

Type of building/ space	Category	Operative temperature for energy calculations °C	
		Heating (winter season), ~ 1,0 clo	Cooling (summer season), ~ 0,5 clo
Offices and spaces with similar activity (single offices, open plan offices, conference rooms, auditorium, cafeteria, restaurants, class rooms, Sedentary activity ~1,2 met)	I	21.0 – 23.0	23.5 – 25.5
	II	20.0 – 24.0	23.0 – 26.0
	III	19.0 – 25.0	22.0 – 27.0
	IV	17.0 – 26.0	21.0 – 28.0

A 2009 study in the journal *Indoor Air* examined temperatures in 100 office buildings and found the average indoor air temperature in the summer was not only cooler than recommended and cooler than the established comfort zone for office workers about 22.9°C, it was cooler even than the temperature set in the winter to about 23.4°C .

In the main studies, where they did the same sedentary work and wore the same type of clothing, there were no differences between the preferred temperature for men and women. So the researchers' finding of a lower metabolic rate for females will not influence the recommended temperatures in the existing standards. Also their study is not conclusive. They only studied 16 females at a sedentary activity. They should also have studied 16 men at the same activity to be able to compare. The reason why we, in some field studies, find that women prefer higher room temperature than men is attributed to the level of clothing. Women adapt better their clothing to summer conditions while men are still wearing suit and tie. So if the thermostat is set to satisfy the men, the women will complain about being too cold. In the standard, this adaptation of clothing to summer is taken into account so if the standard is followed the women would be satisfied; but maybe not the men.

Why are air-conditioned buildings often too cold?

There can be many reasons why buildings are often too cold. Here are some possible explanations:

- Some buildings overcool air to reduce humidity.
- Some Air-Conditioning systems do not work well under part load conditions
- People think the air conditioning isn't working if it's not a little cold
- Being able to make people feel cold in the summer is a sign of power and prestige
- Men stuffed into heavy suits may control the thermostat
- Energy is too cheap giving people little incentive to save on the air conditioning

Conclusions

The extensive studies, which form the basis for existing international standards for the thermal environment (ANSI/ASHRAE Standard 55, ISO EN 7730, EN 15251) included equal amount of male and female subjects and no difference in preference was observed. Despite this fact, we may often find women are colder during summer time in air conditioned offices. This can however, in most cases be attributed to the difference in clothing level between men and women. It seems the thermostat settings in summer in air-conditioned buildings are often too low and below the recommended range in existing standards. ■

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