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Thermal comfort and use of thermostats in Finnish homes and offices

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ABSTRACT

Thermal comfort and use of thermostats in homes and office rooms were examined by a quantitative interview survey with a nationally representative sample in Finland. The total number of respondents was 3094. The results show that thermal comfort levels are lower in offices than in homes. People feel cold and hot more often in offices than in homes during both the winter and summer seasons. The perceived control over room temperature is remarkably low in offices. Higher thermal comfort levels and perceived control in homes are supported by greater adaptive opportunities. In offices people have fewer opportunities to control the thermal environment, people deal worse with thermostats, and people have lower opportunities to adapt to different thermal environments.

1. Introduction

The adaptive approach to thermal comfort pays attention to the interaction between people and their thermal environment [1–8]. The occupants are not seen as passive recipients of thermal environments but play an active role in making themselves comfortable in different thermal environments, for example, by using adjustable thermostats. The fundamental assumption of the adaptive approach is that "if a change occurs such as to produce discomfort, people react in ways which tend to restore their comfort" [8].

Adaptive opportunities include the following:

- clothing adjustment when felt cold and hot,
- occupant control of heating and cooling systems, i.e. use of thermostats (or putting more firewood in fireplace),
- occupant use of openable windows,
- occupant use of window blinds or curtains to control solar lighting,
- occupant use of personal fans,
- drinking cold or hot liquids,
- taking a walk inside or outside,
- moving to another location inside.

The present study gives an overview of thermal comfort in homes and offices in Finland, in a country in which a harsh climate predominates. The key idea of the paper is to compare thermal comfort and perceived control over room temperature in two different environments, home and office room in which adaptive opportunities are very different. The work concentrates especially on the use of thermostats.

2. Method and material

Thermal comfort and the use of thermostats were studied by a quantitative interview survey. The interviews were carried out on the telephone (computer assisted telephone interview, CATI). A well-known Finnish data collection agency (Taloustutkimus Oy) was responsible for the practical realisation of the telephone interviews according to its quality system.

2.1. Respondents

The material concerning both the home environment and the office environment was gathered in the same interviews. The first part of the interview concerned the home environment and the last part concerned the office environment. The latter part of the questions was only asked of persons working in an office (in a work environment away from the home). The sample size in questions concerning the office environment was about one-third of the total; 3094 persons (1556 females and 1538 males) answered the questions concerning the home environment and 1000 persons (520 females and 480 males) the questions concerning the office environment.

The target group of the study was the population of Finland. A random sample of the Finnish population aged between 15 and 74 was selected with quotas set according to gender, age and

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province. A total of 11,003 persons were not willing to participate in a telephone interview or found the participation impossible at the moment of the phone call. The total number of phone calls was 34,935. The number includes also, for example, 4797 false (discontinued) phone numbers. It also includes the phone calls that were not answered, and phone calls to persons that did not belong to the target group of the study, or belonged to a gender, age or province group to which no more respondents were needed.

Although the sample was selected with quotas (by gender, age and province), rather small differences were noticed between the distribution of the population and the study sample. These distortions were corrected with weighting coefficients before statistical analysis.

51% of respondents live in single-family houses, 31% in apartment houses and 17% in two-family (semi-detached) houses or in row houses. 47% of office workers work alone in a single-person room. 26% of office workers share a room with one or two colleagues and 25% work in an open-plan office. The offices typically have shallow plan depths, so the office rooms are close to either an external window or a daylight atrium.

2.2. Climate and buildings

The climate in Finland is marked by cold winters and warm summers. The mean annual outdoor temperature varies between +6 °C in the southwest and −2 °C in the northernmost part of the country. The warmest month is typically July, with mean temperature between +14 and +18 °C in most parts of the country. Daily maximum temperatures can reach +30 °C in July. The coldest months are January and February, with mean temperatures between −4 °C in the south and −15 °C in the north.

Buildings in Finland are well insulated and equipped with centralized heating systems. Room air temperatures are typically between +20 and +24 °C in the winter period. Heating systems are sized to be able to keep the room air temperature over +20 °C also on coldest winter days. The dimensioning outdoor temperatures are −26 °C in the south and −38 °C in the north. During the short summer, room air temperatures commonly rise to +25 to +30 °C. There is a fireplace in 43% of homes, but it is the primary heating system in only 4% of homes. Residential buildings are typically equipped with a mechanical exhaust ventilation system, or are ventilated naturally. The most common ventilation system in office buildings is mechanical ventilation with supply and exhaust. Table 1 gives an overview of the heating, cooling and ventilation systems in Finnish buildings. Fig. 1 shows examples of typical thermostats in Finland.

Table 1
Overview of heat distribution, cooling and ventilation systems in Finnish buildings (at the time the interviews were performed).

		Homes (%)	Offices (%)
Heating (primary)	Circulating water system	68	88
	Electric heating (direct)	23	4
	Warm-air heating	1	4
	Fireplace	4	0
	Other/not known	3	4
	Total	100	100
Cooling	Cooling system of any kind	1	45
	No cooling	99	55
	Total	100	100
Ventilation	Mechanical supply and exhaust	7	59
	Mechanical exhaust	43	27
	Natural	50	14
	Total	100	100

Sources of data: Statistics Finland, Population Register Centre of Finland, and VTT.

2.3. Interviews and analysis

Thermal comfort and perceived control were examined in this study with the next questions and choices for answer.

- How satisfied are you with room temperature in [winter/summer] in [home/office room]? (Very dissatisfied = 1, …, very satisfied = 5).
- How often do you feel uncomfortably [cold/hot] in [winter/summer] in [home/office room]? (Continuously, daily, weekly, monthly, less frequently, not at all).
- How well do you feel you can personally control room temperature in [winter/summer] in [home/office room]? (Very badly = 1, …, very well = 5).

Fig. 1. Examples of typical thermostats in Finnish homes and offices. First row: room thermostats typical of offices. At left in the second row: a room thermostat typical of homes. At centre and right in the second row: thermostatic valves typical of both offices and homes.