Overcooling of Offices Reveals Gender Inequality in Thermal Comfort

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Cooling requirements in the U.S.

**Cooling is increasing**
- Accounted for 23% of increased electricity demand from 1990-2016
- 84% increase by 2050 due to climate change

**Overcooling of offices**
- Offices can be cooler in summer than winter
- Evidence that it is a global problem
- Annual costs:
  - USD 10 billion
  - 8% of total building electricity use
  - 57,000 kt of CO₂e
  - decreased occupant satisfaction

Source: Derrible and Reeder (2015)
IS YOUR THERMOSTAT SEXIST?

Can an Office Temperature Be ‘Sexist’? Women, and Science, Say So

LIVING

Cold office temperatures are hurting women’s productivity, study says
Project overview

Objective
- Explore gender inequity in office overcooling

Approach
- Analyze CBE Occupant Survey responses about office temperatures
- Collect Tweets about cold offices

Funding
- SinBerBEST
- CBE

Source: Shutterstock
Thermal comfort questions in the CBE Occupant Survey

Thermal comfort is a common issue
- 38% of respondents are dissatisfied with the thermal environment
- Second most common issue behind acoustics

Branching questions on temperature
- Dissatisfied respondents evaluate the temperature in summer and winter
- Analyzed over 38,000 responses from 435 offices

CBE Occupant Survey
Example Thermal Comfort Question

How satisfied are you with the temperature of your workspace?

In warm/hot weather, the temperature in my workspace is:
- Often too hot
- Often too cold

In cool/cold weather, the temperature in my workspace is:
- Often too hot
- Often too cold
Overcooling and gender in the CBE Occupant Survey

Takeaways

- Office temperatures are 1.8x more likely to be uncomfortable for women
- Uncomfortable temperatures for women are more likely to be cold than hot, regardless of season
Mining Twitter for cold office complaints

**Novel crowdsourcing method**

- Tweets about cold offices
- Complements the CBE Occupant Survey

**Tweets about cold offices**

- Keyword search for "cold", "office", "freezing", "desk", "🥶" etc.
- Must include geotag and in the U.S.
- Found 16,791 tweets:
  - 14,771 users
  - 3,761 cities
It doesn't need to be this cold in the office 😞
3:22 PM · Jul 30, 2019 from Lancaster, PA

My office is so cold that walking outside in 93 degree heat feels like heaven on my 15 minute break
8:37 PM · Aug 8, 2018 from Florida, USA

Apparently it was over 100 today but i had no idea because I was in my office, freezing and warming myself with my space heater because this building is forever cold.
12:20 AM · Sep 11, 2018 from Santa Rosa, CA

I hate being in a freezing cold building. Like why is that a norm?
9:47 PM · Sep 9, 2019 from Austin, TX
Adding context to cold office tweets

Gender
- Based on Twitter username
- Guess gender using algorithm on list of names from Social Security Administration
- Manual verification found 93% accuracy

Weather
- Based on tweet time and location
- Retrieve daily temperature from nearest weather station on the day of the tweet
- 75% of stations <10 km (6 mi) from user
Gender and cold office tweets

**Guessing gender**
- 66% of the matched usernames were women
- Higher than the estimated 55% of Twitter users who are women

**Text mining of tweets**
- Cooccurrences of frequent words in tweets
- Search keywords (cold, office, building) shown in the center
- Women discussed responses to overcooling e.g., clothing, blanket, heater etc.
Weather and cold office tweets

**Outdoor temperature**
- Tweets were common when daily temperature was above 20°C (68°F)
- Share of tweets from women increased with outdoor temperature

**Regional differences**
- 40% of cold office tweets were from Southern states
- Median temperature was higher for women in all regions
- Similar share by gender in all regions
Solutions to overcooling

**Adjust thermostats**
- Seasonal changes to thermostats would reduce overcooling and save energy
- Likely to improve thermal comfort for women

**Modify HVAC configuration**
- VAV minimum air flow setpoints are too high
- Reduced flow improves comfort, perceived air quality, and lowers energy use

**Use personal comfort systems**
- Meet individual thermal preferences without making office uncomfortable for others
Summary

- Cool office temperatures in summer cause occupant dissatisfaction
- Overcooling disproportionately effects women
- Gender inequity confirmed by two independent datasets
- Existing solutions would improve thermal comfort for all occupants and save energy