# Particle pollution from ovens in kitchens in Danish homes

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## Background

Outdoor air pollution with particles contributes significantly to mortality and morbidity in both developing and developed countries. However, little attention is often given to indoor particle pollution in developed countries. Even though people spend a high share of their lives at home, where smoke from ovens (and food cooking in general) contributes significantly to indoor particle pollution and increases the risk of blood clots, cardiovascular diseases, lung diseases, cancer, etc. Particles from indoor sources air can be just as harmful as outdoor particles. Good kitchen habits and the use of efficient cooker hoods or efficient venting reduce pollution and the connected health risks. However, a representative YouGov survey from December 2024 showed that just 12 percent of Danes always switch on the cooker hood when using their oven. At the same time, there is a fast rise in the sale of ovens built into kitchen cabinets further away from the cooker hood.

## Purpose

The purpose of the study is to perform detailed investigations of particle pollution from cooking food in six traditional ovens under cooker hoods and five ovens built into kitchen cabinets or at kitchen tables (not under hoods) in Danish kitchens.

## Methods

Particles (PN and $PM_{2.5}$) were measured with newly calibrated P-Traks: Model 8525 and DustTraks: DRX Aerosol Monitor 8533 from TSI in 11 Danish kitchens. Before measurements, ovens were carefully cleaned and the efficiency of the cooker hoods were tested. No other pollution sources were active during the measurements. A reproducible standard frying setup preparing two pieces of bacon in the oven was used under the following three test conditions: a) not using the cooker hood, b) using the cooker hood at highest level, c) using traditional venting: through draught or open kitchen window.

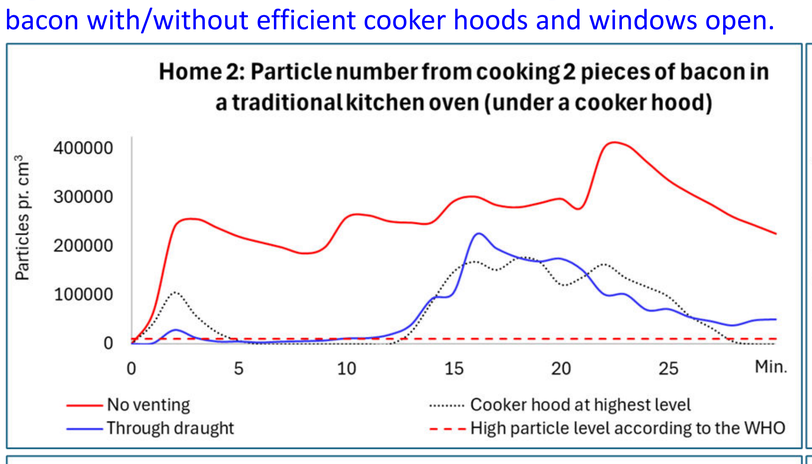


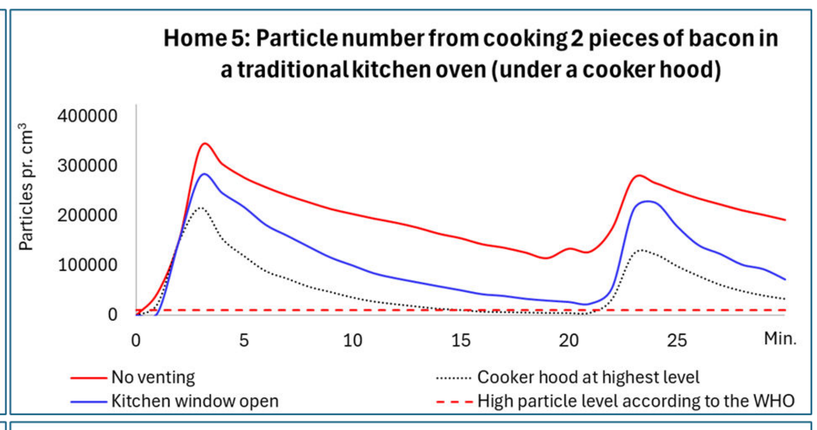
## Results & Discussion

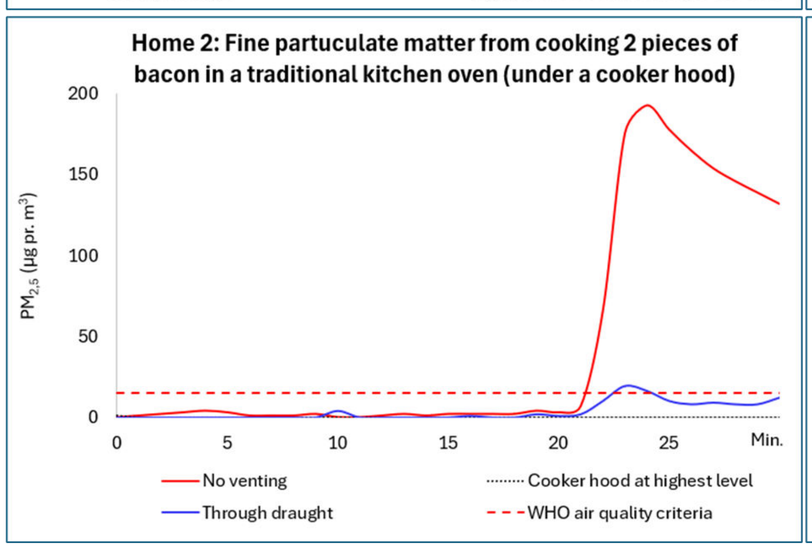
Frying two pieces of bacon under standard conditions in an oven without use of any venting can contribute more than 20 times as much to pollution with PN and $PM_{2.5}$ in the kitchen as the local street traffic contributes to the pollution on one of the most polluted street in Copenhagen during the rush hours (Table 1). The key explanation is that most diesel cars have efficient particulate filters and pollution from traffic is diluted in an extremely large volume of air, while smoke from the oven is only concentrated in the kitchen if not venting. Significantly higher pollution levels would be expected if the oven, baking trays etc. are not cleaned properly, and/or if more than two pieces of bacon are cooked. The pollution easily spreads to the rest of the home if the kitchen door is left open.

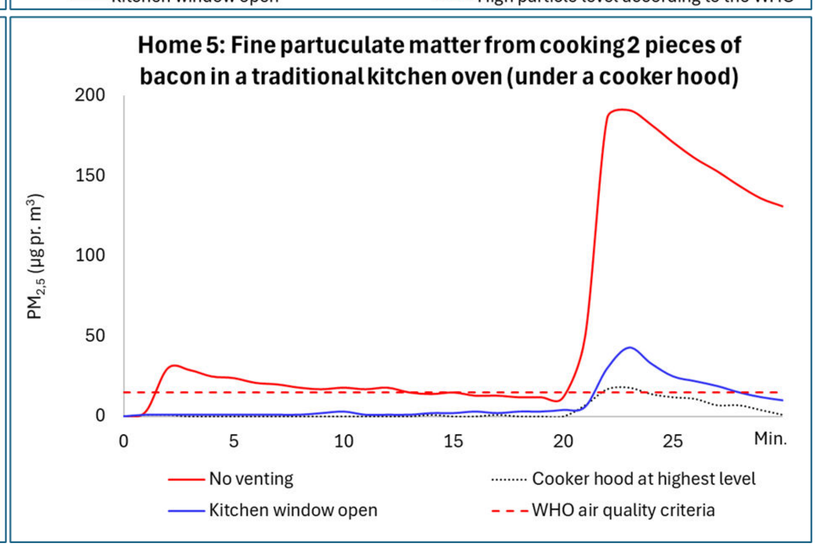
For ovens placed under cooker hoods, efficient hoods and venting with through draught are roughly equally effective at removing PN pollution, while the hoods are more effective than venting with just the kitchen window open. Good hoods are generally better than venting at removing $PM_{2.5}$ (figure 1).

Figure 1: Pollution in kitchens from cooking of two pieces of bacon with/without efficient cooker hoods and windows open.




For ovens not placed under kitchen hoods (e.g. ovens built into kitchen cabinets or stand-alone) same pollution patterns/levels were observed (as figures 1) and efficient cooker hoods were most efficient removing both PN and $PM_{2.5}$. Venting was more efficient to remove particles than inefficient cooker hoods. The location of the windows are important for efficient venting.

A key difference between outdoor and indoor air pollution is that people living in the home typically creates the indoor air pollution themselves. Hence, most indoor air pollution with particles can easily be avoided or minimized by simple changes of habits and technologies like efficient cooker hoods.

Table 1: Average extra particle pollution from cooking two pieces of bacon in the oven and road traffic

| | Venting conditions | Particle number (particles 20-1,000 nm/cm³) | Fine particulate matter (µg/m³) |
|---|---|---|---|
| **Home 2** | No venting | 256,695 | 45 |
| | Cooker hood at highest level | 65,370 | 0 |
| | Through draught | 65,215 | 3.5 |
| **Home 5** | No venting | 198,700 | 60 |
| | Cooker hood at highest level | 57,075 | 3.5 |
| | Kitchen window open | 109,510 | 8 |
| **Local traffic contribution at HCAB[1] in the morning rush hours (8.00-9.00)** | | 5-10,000 | 1-2 |

1) H.C. Andersens Boulevard in the central Copenhagen that is one of the most polluted streets in Denmark.

## Conclusion

This study confirms that pollution from ovens without venting will expose people in the home to high levels of PN and $PM_{2.5}$ pollution. Exposure can be reduced significantly by using an efficient cooker hood or by venting during cooking with open windows. Through draught is most efficient removing particle pollution compared to just an open kitchen window. Much more attention should be given to indoor particle pollution.

## Perspectives

There is an urgent need for much more public information on the importance of using an efficient cooker hood - or other efficient venting - when cooking in ovens, frying, toasting etc. to prevent high levels of health damaging pollution in homes. Building Codes should include specific requirements to reduce particle pollution from cooking. Key advises to oven users:

- Keep the oven, baking sheets etc. clean.
- Make sure not to burn food in the oven.
- Keep the kitchen door closed to avoid particles from food cooking spreading to the rest of the home.
- Buy a stove where fumes from the oven are discharged at the back towards the wall to rise upwards into the cooker hood.
- Use an efficient cooker hood (exhausting to the outside) on a high level every time you use the oven (and other cooking).
- Turn off the air venting function of the oven a minute before opening the oven door and open the door slowly.
- Close the oven door and vent the kitchen for 5-10 minutes after the food has been cooked.
- Install mechanical ventilation that is balanced and supports the function of the cooker hood.

## Lead author

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