

BREATHE EASY?

Air pollution has been making big headlines in 2017. In the UK and around the world, scientists, doctors and lawmakers have been sounding ever-louder warnings about the dangers lurking in the air we breathe. It's right to be concerned – especially as we come to know more about the different sources of air pollution and their

effects on people – but perspective is key. Official figures show that, nationally, the UK's air is getting cleaner, but in towns and cities, air pollution often breaches legal limits.

Here, we investigate air pollution in the home, give our unique take on the diesel debate (p23) and also weigh up your options for buying a cleaner car (p28).

The hidden air pollution in your home



How much impact do everyday activities such as cooking, cleaning and using scented products have on the air quality of our homes? **Joanna Pearl** investigates, and discovers some surprising results

AT A GLANCE

- The air pollutants in your home and how they could affect your health
- What action you can take to minimise home air pollution
- Why you should examine the household products you buy

Air pollution suggests busy streets and car exhausts. But we spend 90% of our lives indoors and, as our research shows, many of the everyday things we do can create odourless and unseen gases, chemicals and small particles that could make us sick.

We wanted to see just how much pollution was generated by bursts of multiple common household activities, and look at how this might affect our health in the long term. So we found three ordinary houses – from the Victorian era, the 1950s and a new-build – and carried out various everyday activities within them, including vacuuming, cleaning, using air fresheners and candles, and even cooking a fry-up and burning toast. Before and immediately after doing all of this we measured the air quality to see what the difference was.

Indoor pollutants and their health risks

We discovered surprisingly high levels of pollutants with potential cumulative long-term health effects in all of our test houses. These included:

■ **Particulate matter** Tiny particles from combustion, such as smoking, wood and coal fires, gas-cooking and even electric toasters and candles. These can be inhaled, increasing the risk of lung and heart disease if at persistently high levels.

■ Volatile organic compounds (VOCs)

These chemicals evaporate into the air at room temperature, forming vapours that we breathe. They include limonene and pinene (familiar lemon and pine smells used in scented toiletries and bathroom cleaners), which can react with ozone from outdoor air to form the gas formaldehyde and other irritants. Exposure to very high levels of VOCs can cause symptoms such as eye, nose and throat irritation, headaches and nausea and, in the long term, even damage the liver, kidneys and central nervous system.

■ **Carbon dioxide** High levels of carbon dioxide over time can cause sleepiness and impaired thinking, and can particularly affect those with lung problems.

The impact of poor ventilation

Ventilation (measured in air changes per hour – ac/h) is critical for a healthy home, especially in the bathroom and the kitchen. It's generally considered that the air change rate in these two rooms should be around 2 or 3ac/h, largely because of the potent sources of water vapour in bathrooms, and of steam, cooking fumes and other cooker emissions in kitchens.

Even the Victorian house, although the best ventilated, had below-optimum ventilation in its kitchen and bathroom, as you can see in the table below. But, perhaps surprisingly, the highest levels of air pollution weren't in our energy-efficient new build, but in our 1950s semi, where the kitchen and bathroom air change rate both measured just 0.2ac/h. Here, home improvements including cavity wall and roof insulation, double-

glazing and other energy-efficiency measures may have made the house overly 'airtight'.

So, as we do the right thing and make our homes energy efficient, there's a hidden cost: a perfect storm of poor ventilation and air pollution.

Who's most at risk and what can you do about it?

Some people are more susceptible to the effects of indoor pollutants – for example, if you suffer from asthma, are sensitive to allergens indoors or have heart and lung disease. Over the page we give more details about each pollutant we measured and show how to mitigate your exposure to them.

We're not suggesting you should worry about every candle you light, or open all the windows, even in the freezing winter – our discoveries are more about potential cumulative effects over the longer term. But there are certain things you can do to limit the risks. Our tips over the next few pages go into more detail, but in essence, choose products that will minimise indoor pollution, and maximise ventilation by opening windows and trickle vents if you have them, and using bathroom and kitchen extractor fans.

Our research

Lab technicians undertook snapshot measurements of air-quality and ventilation rates in two semi-detached houses – a 'draughty' Victorian and a 1950s house with many insulating improvements – and a new-build end-of-terrace. They did this in winter conditions (with the windows closed) before, and almost immediately after, concentrated bursts of common household activities. These activities were carried out in the kitchen, bathroom and living room or bedroom and included vacuuming, cleaning, cooking and using personal care and scented products. Professor Paul Harrison, an independent specialist in indoor air quality, analysed our lab data. >

VENTILATION			
	VICTORIAN	1950s	NEW BUILD
Kitchen	1.5	0.2	0.6
Bathroom	1	0.2	1.2
Living room	2.2	0.4	0.6

Measured in air changes per hour (ac/h)

THERE'S SOMETHING IN THE AIR...



VOLATILE ORGANIC COMPOUNDS (VOCs)

What are they?

Chemicals found in a wide variety of materials in the home evaporate into the air at room temperature, producing vapours that we inhale.

What's the risk?

Different classes of VOCs have different risk levels: for example, benzene (from petrol and cigarette smoke and, potentially, from paints and solvents) is high risk, whereas terpenes, including limonene and pinene

which give lemon and pine smells to cleaning products, are considered lower-risk. However, some VOCs (especially terpenes) can combine with ozone from outside air, particularly during hot weather, to form gases including formaldehyde. This is a lung irritant that can cause allergic reactions, and, at very high levels, is carcinogenic.

Formaldehyde can also be released from new flat-pack furniture, lino and carpet, fabrics, bedding, glues and insulation. Our new-build house had higher levels of formaldehyde, perhaps due to the new furniture and floorboards combined with low ventilation levels.

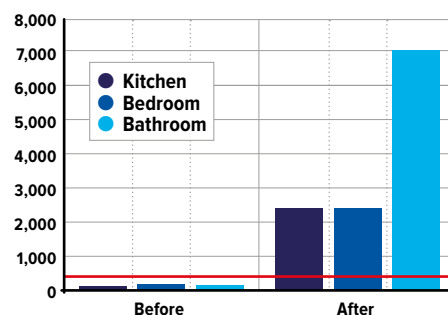
What we found

We found very high levels of VOCs (up to 34 times the UK Building Regulations recommended maximum level – although measured over a busy 30 minutes, not 24 hours) in every room we tested. This was after activities including burning candles and using plug-in air fresheners, scented washing powder and toiletries such as anti-perspirant and perfume. In our 1950s bathroom we measured what our expert Professor Harrison termed as a 'dramatic 46-fold increase' in VOC levels.

What can you do?

- Buy unscented or allergy-friendly products.
- Use easily inhaled sprays and aerosols in moderation, with good ventilation.
- Buy water-based, rather than solvent-based, paints that are low in odour and VOCs.
- Use product-free alternatives, such as dusting with a damp cloth or an electrostatically charged duster instead of fragranced furniture polish.
- Identify and eliminate what's causing smells, rather than using air fresheners.

VOC levels (ppm) in the 1950s house, plus the guideline level (red)



PARTICULATE MATTER

What is it?

Tiny particles can enter your lungs, potentially causing serious health problems over time. In the home, particulate matter generally comes from combustion processes, such as cooking, smoking and using electric

toasters, candles, wood-burning stoves and all open fires. But they can also come about through dusting and vacuuming.

What's the risk?

High levels of particulates can inflame the airways, cause or exacerbate lung and heart disease and even shorten people's lifespans.

What we found

We saw large increases in all of our test-house kitchens. In our 1950s house the particle counts rose by as much as a factor of 560, probably due to a combination of using multiple gas rings, cooking a fry-up, burning toast in the toaster and introducing flowers – all exacerbated by poor ventilation.

What can you do?

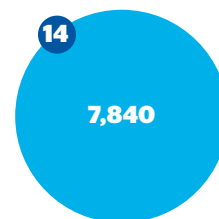
- Use extractor fans or cooker hoods and open the windows or any trickle vents.
- Vacuum regularly to control airborne particles, preferably with a vac that sucks up dust with minimum emissions back into the air. Consider a HEPA filter

if you have allergies, and see which.co.uk/vacs for our Best Buy vacuum cleaners.

- If you have a wood-burning stove or fire, burn only untreated, fully dried wood. Ensure the flue damper is wide open before you use it. Clean the flue and chimney regularly so smoke can escape efficiently.

Particulate levels in the kitchen of our 1950s house

- Before activities
- After activities including cooking, hand-washing and introducing a bunch of flowers



Increase: x560

Units are $\mu\text{g}/\text{m}^3$. Measured in PM_{10} particles, ie size equal to or less than $10\mu\text{m}$, around a tenth of the width of a human hair.



CARBON DIOXIDE AND CARBON MONOXIDE

What are they?

Gases including carbon monoxide (CO) and carbon dioxide (CO₂) are emitted by appliances that burn fuel, such as open fires and gas cookers. Carbon monoxide is produced when carbon-containing fuel burns without adequate oxygen, for example by poorly maintained gas heaters and boilers, and portable gas or paraffin heaters with no flue. CO₂ is produced by human respiration and burners operating normally.

What's the risk?

Carbon monoxide is an odourless, but potentially deadly, toxic gas. Every home should have at least one working carbon monoxide detector, correctly positioned.

High levels of carbon dioxide are often seen as an indicator of ventilation problems. Very high levels for extended periods of time can result in drowsiness, dizziness and headaches. Individuals with lung disease and impaired lung function could be particularly affected.

What we found

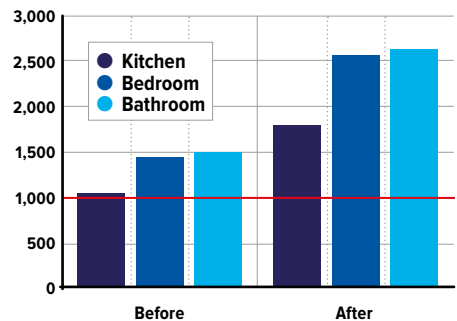
Thankfully, the levels of carbon monoxide in all three test houses were negligible, but Professor Harrison deemed the tested levels of carbon dioxide in all of the houses 'surprisingly high'. They frequently exceeded the established comfort guidance limits of 1,000 parts per million (ppm) – see the graph on the right.

In the kitchen of our Victorian semi they reached 2,950ppm, approaching three times the 'comfort guidance' (although measured over bursts of activity rather than a day). This was likely to be due largely to the heavy use of the gas hob, combined with respiration and poor ventilation.

What can you do?

- Don't use unvented appliances, such as freestanding gas and paraffin heaters.
- Regularly service and maintain appliances such as cookers and heaters (and flues, where present).
- Ventilate bedrooms, especially when you're asleep, to avoid a build-up of CO₂ and moisture.
- Discolouration of the walls might be caused by soot from candles. Consider reducing their use.

CO₂ levels (ppm) in new-build house, plus the guideline level (red)



OTHER POLLUTANTS

Radon, nitrogen dioxide, water vapour and condensation, bacteria, mould, fungal spores, dust-mites and pet dander (flecks of skin/fur)

What are they?

Radon is a radioactive gas and carcinogen, released by the uranium that occurs

naturally in rocks and soils. In most areas of the UK, levels are low and the health risk is small. Homebuyers' surveys usually identify whether a property is in a high-radon area.

Nitrogen dioxide is produced by combustion. In homes with gas stoves, kerosene heaters or unvented gas-space heaters, indoor levels often exceed outdoor levels, possibly increasing the effects of exposure to allergens such as house dust-mites, and irritating the eyes, nose, throat and respiratory tract.

Water vapour is produced by activities such as cooking, cleaning, and washing and drying clothes. It encourages microbiological growth and the production of particulates we inhale, such as fungal spores and dust-mite allergens, potentially causing breathing problems. Dampness and mould can also pose serious health and breathing risks.

What can you do?

- If your home is in a radon-affected area, levels can be measured and action implemented – for more information visit ukradon.org.
- For nitrogen dioxide, see our carbon monoxide and dioxide advice above.
- Heat your home sufficiently (15 to 20°C), while maintaining adequate ventilation with windows, trickle vents and extractor fans.
- Keep boiling pans covered and use a timer to limit shower times.
- Avoid drying laundry indoors.
- Close doors between damp basements and living areas, and consider using a dehumidifier to reduce persistent moisture in the air.
- Encase pillows and mattresses in dust-mite-proof covers.
- Discourage pets from beds and upholstered furniture to minimise your exposure to pet dander.

EXPERT VIEW

INDOOR AIR QUALITY

Dr Stephanie Kipling,
Which? scientific adviser



The quality of the outdoor air we breathe and its health effects make for powerful

headlines, with the government monitoring air quality. But step inside, into your own home, and it's a completely different story.

In workplaces, employers are required to provide ventilation for adequate fresh air. Inside our own homes however, the quality of the air is in our own hands. You'd be forgiven for not giving it much thought, as many of the pollutants we tested for in three houses are too small to see, invisible or odourless. But our tests show that everyday activities and household products can significantly influence indoor air quality.

While the activities we performed were relatively short-term – making

a fry-up, cleaning the bath, vacuuming – it's the prolonged exposure to the generated pollutants that could cause health problems. These problems are likely to be more noticeable in individuals with pre-existing respiratory conditions, such as lung disease and asthma.

Minimise the risk

As no one would think it's a good idea to stop cleaning their bathroom, how can you minimise the potential risks? The ingredients labels of many household products are either

a baffling list of chemicals or contain the vague term 'perfume'. EU legislation requires manufacturers to identify 'perfume' regardless of concentration, but specific compounds are often not stated.

It's up to us to take responsibility for our own homes and health. The easiest ways to do this are to maintain good ventilation and minimise exposure to these potentially harmful substances. Follow our advice over these pages, and if you're at all concerned about your health, contact your GP.

Take action on indoor air pollution

■ **Don't live in a sealed box.**

Be sure to maintain adequate background ventilation at all times and don't block or close existing ventilation provision, such as air bricks.

■ **Ventilate during and after polluting activities** such as cooking, vacuuming and using toiletries – open windows and vents, or use extractor fans.

■ **Use cleaning products, air fresheners and personal care products in moderation and with good ventilation.**

■ **Ventilate well during home improvement**, such as painting and decorating, and ensure odours have dissipated before using the room. Ideally choose paints that have low VOC levels.

■ **Don't forget about outdoor air coming in.** If you live near a busy road, for example, keep the windows closed during hours of peak traffic.

■ **If you're particularly worried about air quality**, consider buying an air purifier. See p60 for the best recommendations from our test lab.

INDOOR POLLUTANTS AND THEIR SOURCES



■ **Bathroom**

Mould and mildew from condensation, VOCs from cleaning and personal care sprays and aerosols or air fresheners.

■ **Kitchen**

Carbon monoxide (CO), carbon dioxide, nitrogen oxides (including NO₂) and particulates from gas cookers/stoves; VOCs from scented household products.

■ **Bedroom**

Dust and dust mites from bedding, bacteria and viruses, pet dander; VOCs from scented toiletries.



■ **Living areas**

VOCs and formaldehyde from scented candles and air fresheners, carpets, paints, glues and furniture; particulates from tobacco smoke, candles, dusting

and vacuuming, pet dander, dust-mites and pollen from flowers; lead from old paint. Carbon monoxide (CO) and NO₂ from open fire or wood-burning stove; radon from soil/bedrock.



■ **Basements**

Water vapour from damp and condensation, which can encourage microbiological

growth of particulates including mould and fungal spores.



■ **Built-in garage**

Car exhaust gases; mould and mildew; VOCs from petrol, stored paints and solvents; pesticides and herbicides.



THE BOTTOM LINE

We discovered that bursts of activity including cleaning, cooking and using scented products can massively increase the levels of air pollutants in our homes. These include tiny particles that we breathe in and chemicals we inhale as vapour that could have long-term cumulative effects on some people's health. We spend 90% of our time indoors, so it's really important to increase ventilation and minimise the sources of air pollution in our homes – for example, by buying different products or moderating their use – to avoid any long-term health effects.

FIND OUT MORE

Related Which? articles:

- Read our first-ever air purifier tests and reviews on p60
- Dehumidifiers test lab, Feb 2017, p73
- Carbon monoxide alarms test lab, Nov 2016, p72

What do you think?

● Is air pollution inside something you've ever even considered? If it is, what do you do to keep your home ventilated? Tell us at which.co.uk/air