

BERLIN

Healthy air, healthier children

Polluted outdoor air contributes
to poor air quality inside classrooms



HEAL
HEALTH AND
ENVIRONMENT
ALLIANCE

Summary

The dangers of air pollution

In the EU, each year
air pollution causes
± 400,000
premature deaths
and hundreds of billions
of euros in health costs

Air pollution from energy production, transport, industry, agriculture and households is the number one environmental threat to health in Europe and globally¹. The World Health Organization (WHO) recognises air pollution as a leading risk factor for major chronic diseases in adults, including heart and lung disease as well as cancer. It also states that no level of air pollution can be considered safe². Each year, air pollution causes around 400,000 premature deaths and hundreds of billions of euros in health costs in the EU alone³.

Breathing in air pollutants - particulate matter, for example, which are tiny particles much thinner than a human hair - can lead to changes in the body that damage health. Poor air quality is linked to chronic and acute respiratory diseases, such as bronchitis and the aggravation of asthma, heart disease and stroke. People already suffering from disease, those living in cities or who are economically deprived are particularly at risk from the harmful effects of polluted air⁴.

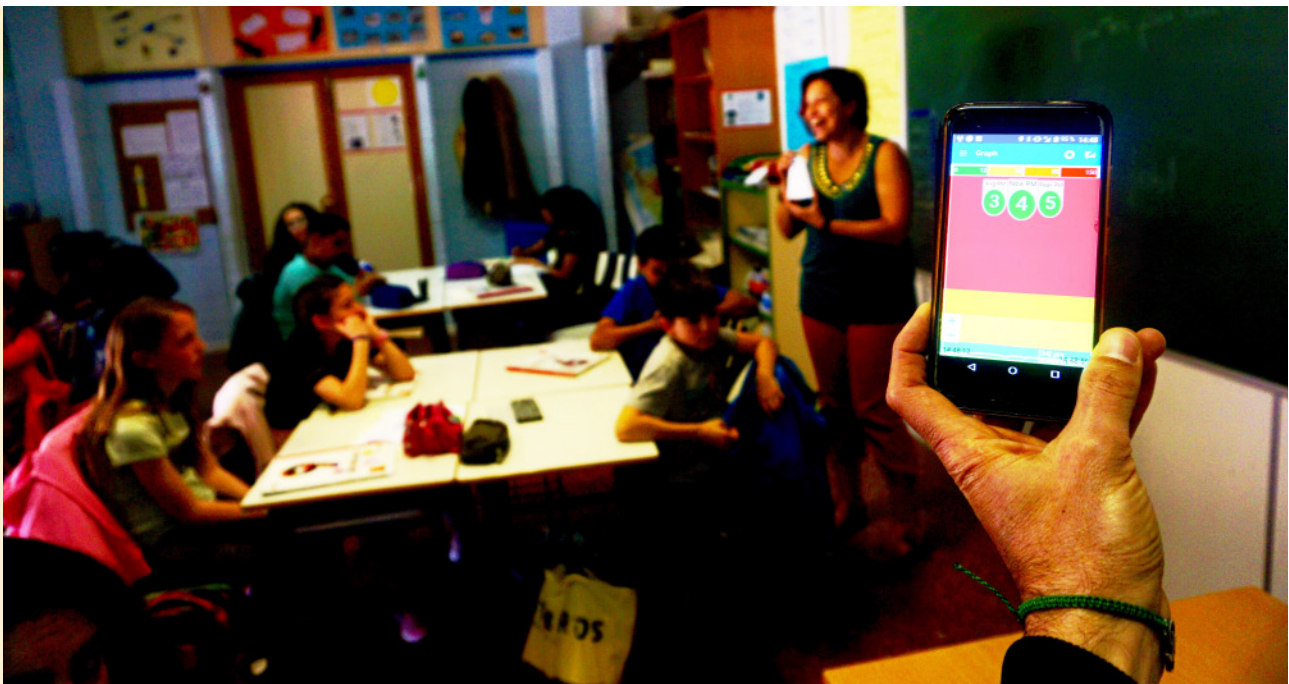
In cities, emissions from cars, buses and lorries are a major contributor to poor air quality, in particular emissions of nitrogen dioxide (NO₂). NO₂ contributes to the formation of particulate matter with related health impacts, and is often considered an indicator for traffic-related air pollution. Studies have shown that NO₂ can lead to asthma and make health problems of asthmatic people worse. Researchers are also investigating a possible link between NO₂ and heart disease and diabetes⁵.

Children and air pollution



Even more worrying is evidence of the toll it takes on children⁶. Children are exposed to air pollution in different ways to adults such as being closer to a vehicle exhaust. Exposure to air pollutants can increase the risk of a child developing asthma and the number and severity of asthma attacks, affect their learning abilities, as well as a child's heart, brain and nervous system development. Effects even affect the unborn child: pregnant women breathing unhealthy air can lead to children being born earlier, or with a lower birth weight, which increases the risk of disease decades later^{7,4}.

HEAL's project



► Air monitoring device to measure particulate matter in and outside classrooms | © AEEA |

To raise awareness of air pollution in school environments and how it affects children's health, **HEAL developed a citizen science initiative to monitor indoor and outdoor air pollutants around primary schools in six capitals of the European Union – Berlin, London, Paris, Madrid, Sofia and Warsaw.**

These cities and also the countries that they are located in currently fail to meet EU air quality standards. Berlin, Paris, London and Madrid have breached limits for nitrogen dioxide (NO₂); Spain is breaching both NO₂ and PM EU air standards; and Bulgaria and Poland have been found to breach EU air quality legislation for PM by the EU Court of Justice⁸.

School environments have received less attention in both research and policy-making, which has largely focused on regulating outdoor air quality. At EU level, a comprehensive set of laws is in place to ensure good outdoor air

quality and to cut emissions from the main pollution sources. The quality of indoor air is significantly affected by outside air, as well as indoor factors⁴. People spend the majority of their time indoors, with children spending up to a third of their day at school, and yet no comparable framework exists for indoor environments.

During March, April and May 2019, 50 schools in these six cities participated in the initiative using low-cost monitoring devices to collect data on common air pollutants. NO₂ was monitored continuously for a period of three to four weeks and local partners visited each school to take a 20 minute measurement of the PM concentration in and around the schools and the CO₂ levels inside the classrooms.

Air quality monitoring



- Particulate Matter (PM) is the pollutant of greatest concern to health as tiny particles can enter the bloodstream. This project looked at both PM_{2.5} and PM₁₀, the number indicating the size of the particles.
- Nitrogen Dioxide (NO₂). NO₂ is a pollutant often used to indicate air pollution from traffic, and it contributes to the formation of particulate matter. Studies also show it causes and aggravates asthma.
- Carbon Dioxide (CO₂) measured inside the classroom. CO₂ acts as an indicator of indoor air quality and ventilation. Inside CO₂ levels can rise high enough to cause drowsiness, affecting concentration and productivity⁹.

This report uses a limit value of 1,000 parts per million (ppm) for CO₂ as the threshold for healthy indoor air. The European Union has set legally binding standards and the WHO has set guidelines for the maximum average concentration of PM and NO₂:

Pollutant	Period	EU Air Quality Directive	WHO Guidelines
		Concentration (limit value µg/m ³)	Concentration (limit value µg/m ³)
PM _{2.5}	24 Hours	-	25*
PM _{2.5}	Annual	25	10
PM ₁₀	24 Hours	50**	50*
PM ₁₀	Annual	40	20
NO ₂	Hourly	200***	200
NO ₂	Annual	40	40

* 99th percentile - 3 days/year

** not to be exceeded more than 35 days a year

*** not to be exceeded on more than 18 times a year

In response to the public health threat that air pollution brings to those living in cities, more and more grassroots organisations and individuals are using low-cost devices to raise awareness of the need for clean air and to improve the knowledge of the exposure and vulnerability of different population groups. This local data can be useful to compare with official monitoring stations and other collected data to stress the need for pollution reduction measures in communities.

This HEAL initiative is a contribution to this growing movement, providing a snapshot of air quality in and around schools in different cities, as well as recommendations for local authorities and school communities to discuss further. With the active participation of schools and children, this pilot initiative is one of the largest of its kind to use a coordinated, citizen science approach to measure both indoor and outdoor pollutants to date in Europe.

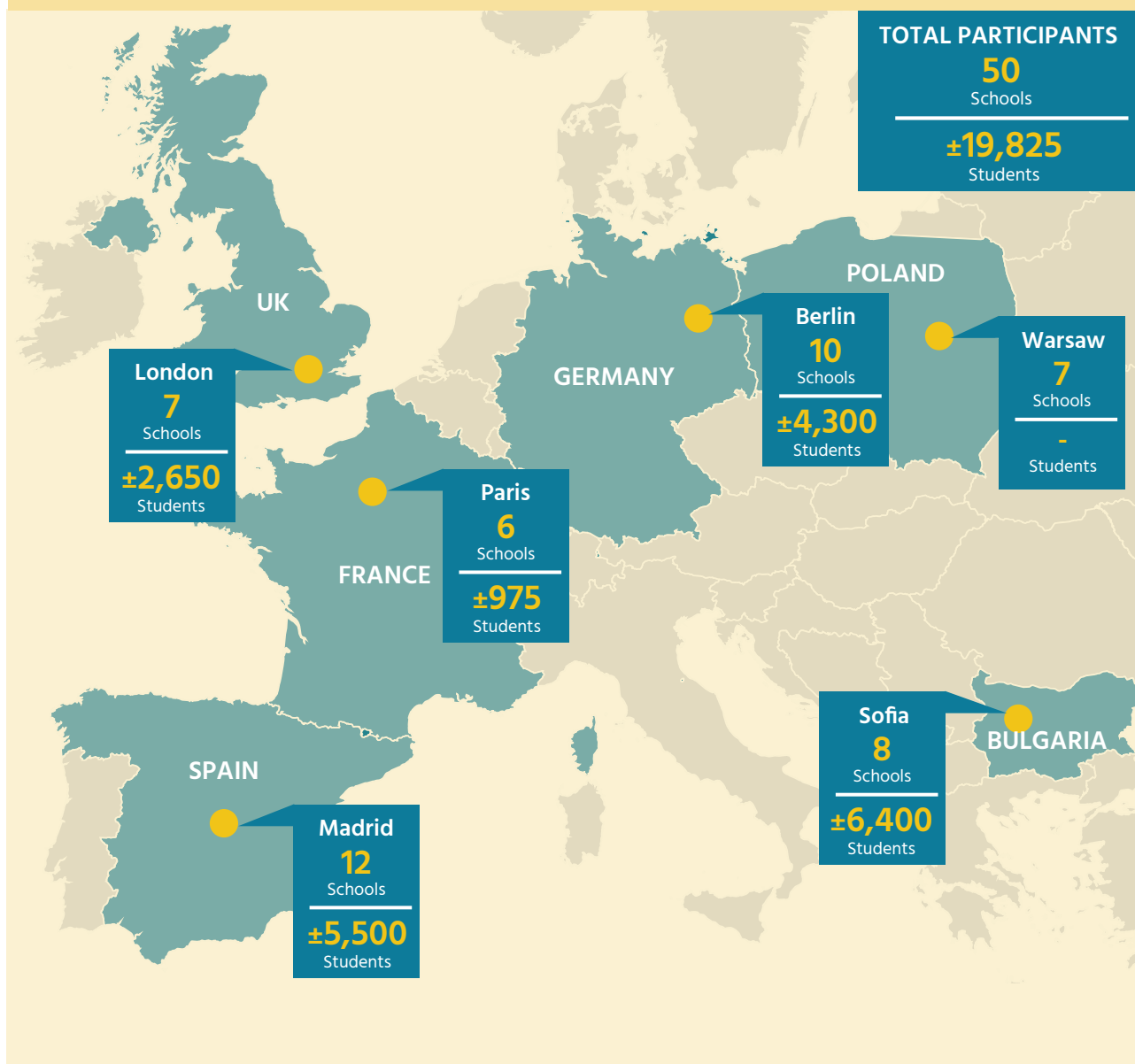
Findings of the HEAL snapshot – Indoor and outdoor monitoring at schools in six capital cities in Europe

HEAL's citizen science monitoring found various unhealthy air quality concentrations in and outside classrooms where children spend the majority of their day. A detailed analysis of the results in Berlin can be found further in this report.

Common findings

- At all participating schools, NO₂ was detected inside the classrooms. As there were no sources of NO₂ in classrooms, these NO₂ levels can only come from outdoor air pollution, notably traffic.
- Concentrations of particulate matter varied, and for some schools were higher than what the World Health Organization recommends to protect health.
- The majority of the classrooms had CO₂ values above the recommended level of 1,000 parts per million (ppm), indicating an overall need for more ventilation.

Participating schools and number of represented students across Europe



The results show that there were varying concentrations of unhealthy pollutants inside and outside classrooms.

The variation in the results can be explained by many factors, including proximity to busy roads, the season and characteristics of the building. Understanding how these interact is complex. However, the results do clearly demonstrate that outdoor pollutants enter school buildings and influence indoor air quality. Since there are no indoor sources of NO_2 , the concentrations detected indicate the contamination of indoor air by traffic-related emissions.

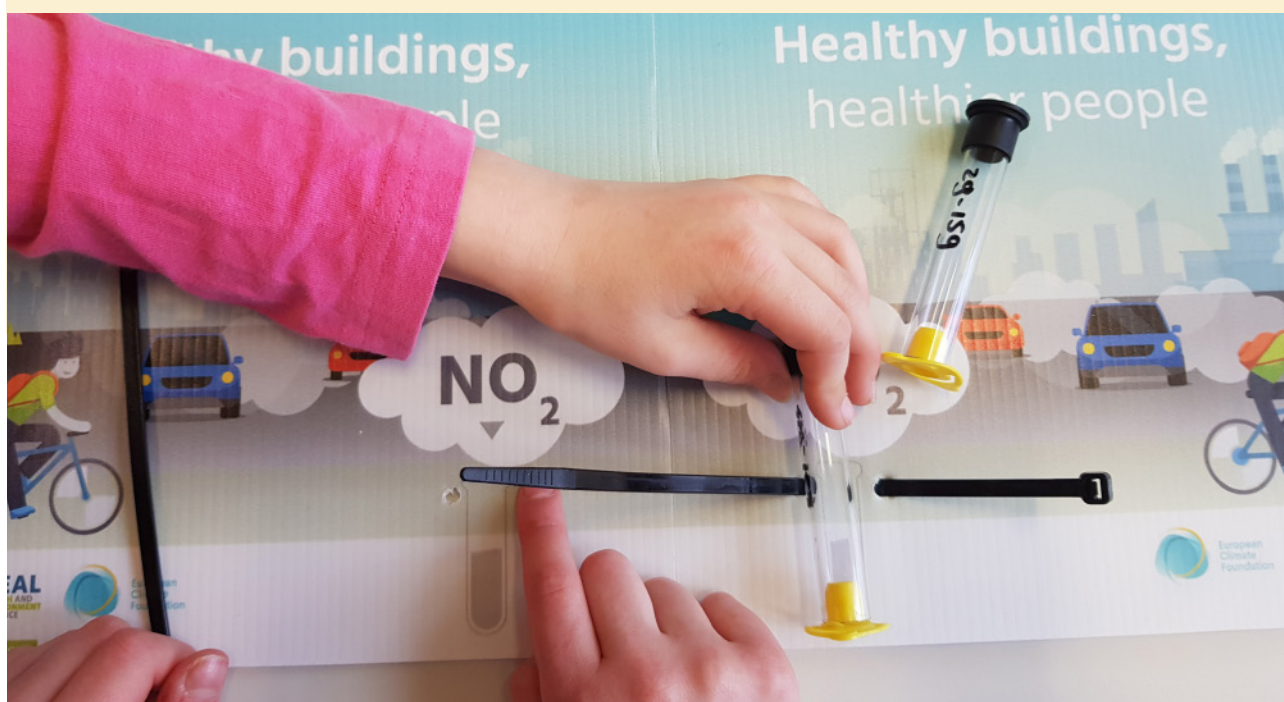
It is important to highlight that the concentrations shared in this report do not remain steady throughout the day, or over the year, but vary as PM and NO_2 concentrations are influenced by traffic, the weather, use of heating, or ventilation. In order to determine the health risk to children, longer and continuous monitoring is needed.

The indoor environment cannot be separated from the outside world. The high values of CO_2 observed in a majority of the classrooms underlines the need for ventilation. To prevent drowsiness, loss of concentration, and decreased productivity, it is important to ventilate regularly. Renovations for energy

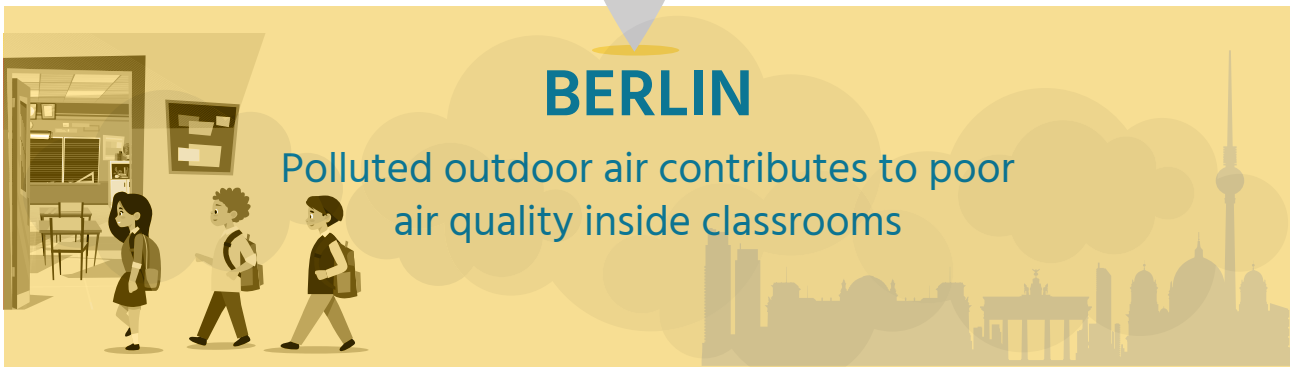


► Hitherfield Primary School and Children's Centre, London, pupils engaged in the project in the school playground. | © Sustrans |

efficiency are an opportunity to address these ventilation challenges, leading to healthier learning conditions. More attention is needed to link health and energy efficiency considerations so that schools and buildings generally can be climate and health friendly at the same time. Yet, as long as the outdoor air is polluted, schools will struggle to achieve good indoor air quality. The outdoor air needs to be cleaned up, so that children can learn well and develop healthily.



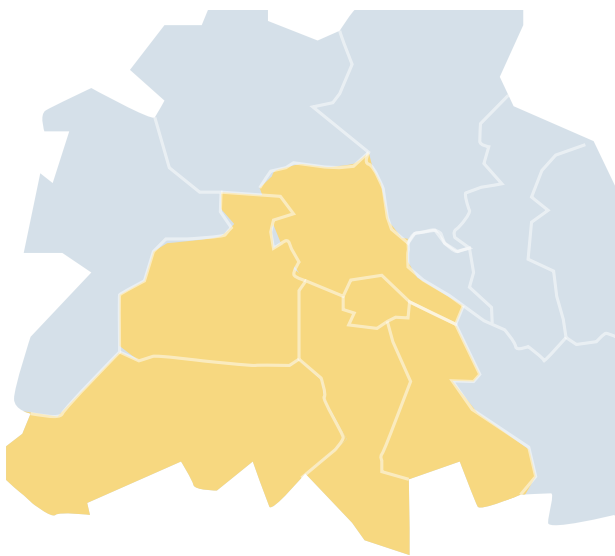
► Citizen science monitoring - children help to set up monitoring tubes for nitrogen dioxide (NO_2) in the classroom | © HEAL |



As in many German cities, the air quality in Berlin is poorer than what is necessary to protect health. The annual EU standard for NO_2 has been exceeded year after year and PM_{10} standards have not been complied with since 2009¹⁰. After being convicted by the Berlin administrative court, the city authority has decided on a new clean air plan at the end of July 2019 with a

focus on reducing NO_2 , including driving bans for diesel vehicles in eight road sections¹¹. While there has been success in cutting air pollution from industry, energy and heat generation, transport is now the main polluting sector. Berlin has introduced a low emission zone and provides incentives for sustainable transport modes¹².

Summary



- Ten public primary schools in Berlin
- School population represented: $\pm 4,300$ pupils
- All ten schools were at a busy location and covered the areas of Neukölln, Mitte, Tempelhof-Schöneberg, Steglitz-Zehlendorf, and Friedrichshain-Kreuzberg.

► Geographical location of the schools across Berlin

Results

In Berlin, the air quality in and around ten primary schools was measured. NO₂ concentrations were detected outdoors at all schools and surprisingly also inside the classroom. Two schools' NO₂ results were actually higher inside the classroom than outdoors at the school entrance. As there should be no sources of NO₂ in the classroom, this indicates that NO₂ travelled from outside into the rooms.

None of the ten schools had healthy levels of CO₂ when the measurements began, and one school had CO₂ levels over 3x the recommended levels. After opening the windows some classrooms reached values below 1,000 ppm, however, not all schools were able to lower the CO₂ concentration. Some of the schools informed the project team that due to safety measures, they were not allowed to fully open the windows, preventing proper ventilation.



► NO₂ monitoring tubes outside a Berlin school | © HEAL |

Schools	NO ₂ outdoors (µg/m ³) <i>Measured over a four-week period</i>	NO ₂ indoors (µg/m ³) <i>Measured over a four-week period</i>	PM _{2.5} outdoors (µg/m ³) <i>Measured over a single 20-minute period</i>	PM _{2.5} indoors (µg/m ³) <i>Measured over a single 20-minute period</i>	PM ₁₀ outdoors (µg/m ³) <i>Measured over a single 20-minute period</i>	PM ₁₀ indoors (µg/m ³) <i>Measured over a single 20-minute period</i>	CO ₂ (ppm) <i>Maximum value measured over a single 20-minute period</i>
Berlin school 1	25	11	4	2	5	18	1300
Berlin school 2	20	22	14	16	24	31	1995
Berlin school 3	31	12	6	3	9	5	2220
Berlin school 4	6	13	3	4	4	6	2100
Berlin school 5	17	12	4	10	5	20	1800
Berlin school 6	19	7	6	3	6	9	2750
Berlin school 7	18	10	4	1	8	4	2400
Berlin school 8	13	5	5	18	5	40	>3000
Berlin school 9	18	7	14	13	22	21	1680
Berlin school 10	20	7	19	5	27	9	2630

Conclusions and Recommendations for Berlin

The results in Berlin clearly illustrate that indoor air quality is influenced by outdoor air pollution. The concentrations of NO₂ detected in the schools in Berlin have travelled from outdoors into the schools' interior where they can affect the health of the pupils as they spend a significant part of the day there. The high CO₂ concentrations show that it is necessary to improve ventilation as the levels observed were all far above healthy limits and therefore likely to negatively influence the learning performance of the children. This is a key factor that should be considered when renovating schools for greater energy efficiency. However, as long as the outdoor air is polluted, schools will struggle to achieve good indoor air quality.

The following recommendations should be implemented to counter the negative impacts of air pollution affecting the most vulnerable, such as young children:

- 1 **Make tackling air pollution in schools and other children's environments a political priority.**
- 2 **Discourage and restrict traffic and car idling around schools, for example through including schools in low emission zones or congestion charge areas and the encouragement of car sharing among parents, and use of public transportation, walking and cycling.**
- 3 **Ensure regular ventilation of school classrooms and consider ventilation improvements for health in efforts to reduce buildings' climate footprint.**

The director of one of the schools who prefers to remain anonymous said:

"We are a primary school in the northern center of Berlin. We educators were interested in air quality measurement because many people think that living near a park means that you live and work in a good environment with lots of greenery and fresh air. The measurement shows us a different picture. Although we do not have the worst results, it is still alarming how unhealthy we live and work every day, in what health-harming conditions the children grow up."

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About

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Disclaimer:

The report 'Healthy Air, Healthier Children - 50 schools across the EU monitor air quality' is a snapshot in indoor air quality in 50 schools in six capitals in the EU, based on citizens' science, with schools participating on the basis of interest. Therefore, this report is not a representative analysis of schools' indoor environments, nor did HEAL investigate actual health impacts of children in participating schools. Given the differences in each city (location, geographical conditions, state of the school buildings etc.) and differences in the intervals of measurement it is not possible to make comparisons between schools or cities. However, HEAL's citizen science monitoring demonstrates that providing for clean air schools environments should be a priority for policy-makers, and that further monitoring should be undertaken.

The full methodology can be found on the website of HEAL.

BERLIN



The Health and Environment Alliance (HEAL) is the leading not-for-profit organisation addressing how the environment affects human health in the European Union (EU) and beyond. HEAL works to shape laws and policies that promote planetary and human health and protect those most affected by pollution, and raise awareness on the benefits of environmental action for health.

HEAL's over 70 member organisations include international, European, national and local groups of health professionals, not-for-profit health insurers, patients, citizens, women, youth, and environmental experts representing over 200 million people across the 53 countries of the WHO European Region.

As an alliance, HEAL brings independent and expert evidence from the health community to EU and global decision-making processes to inspire disease prevention and to promote a toxic-free, low-carbon, fair and healthy future.

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