MADRID

Healthy air, healthier children

Traffic pollutes schools and threatens children's health

HEAL
HEALTH AND ENVIRONMENT ALLIANCE

Summary

The dangers of air pollution

In the EU, each year
air pollution causes
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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 globally[1]. 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 safe[2]. Each year, air pollution causes around 400,000 premature deaths and hundreds of billions of euros in health costs in the EU alone[3].

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 air[4].

In cities, emissions from cars, buses and lorries are a major contributor to poor air quality, in particular emissions of nitrogen dioxide (NO_2). NO_2 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 NO_2 can lead to asthma and make health problems of asthmatic people worse. Researchers are also investigating a possible link between NO_2 and heart disease and diabetes[5].

Children and air pollution

Even more worrying is evidence of the toll it takes on children[6]. 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].

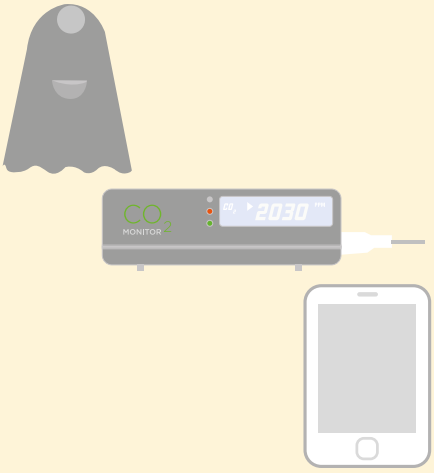
HEAL's project

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 where they are located in currently fail to meet EU air quality standards. Berlin, Paris, London, Madrid have breached limits for nitrogen dioxide (NO_2); Spain is breaching both NO_2 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 Justice[8].

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 inside air is significantly affected by outside air, as well as indoor factors[4]. 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. NO_2 was monitored continuously for a period of three to four weeks and local partners visited each school to take a 20 minutes measurement of the PM concentration in and around the schools and the CO_2 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 PM_{10}, the number indicating the size of the particles.
- Nitrogen Dioxide (NO_2). NO_2 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 (CO_2) measured inside the classroom. CO_2 acts as an indicator of indoor air quality and ventilation. Inside CO_2 levels can rise high enough to cause drowsiness, affecting concentration and productivity[9].

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 data from official monitoring stations, or other collected data, and to bring home the message on 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 to use a coordinated, citizen-science approach to measure both indoor and outdoor pollutants to date.

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This report uses a limit value of 1000 part per million (ppm) for CO_2 as the threshold for healthy indoor air. The European Union has set legally binding standards and the WHO have set guidelines for the maximum average concentration of PM and NO_2:

		EU Air Quality Directive	WHO Guidelines
Pollutant	Period	Concentration (limit value µg/m³)	Concentration (limit value µg/m³)
$PM_{2.5}$	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

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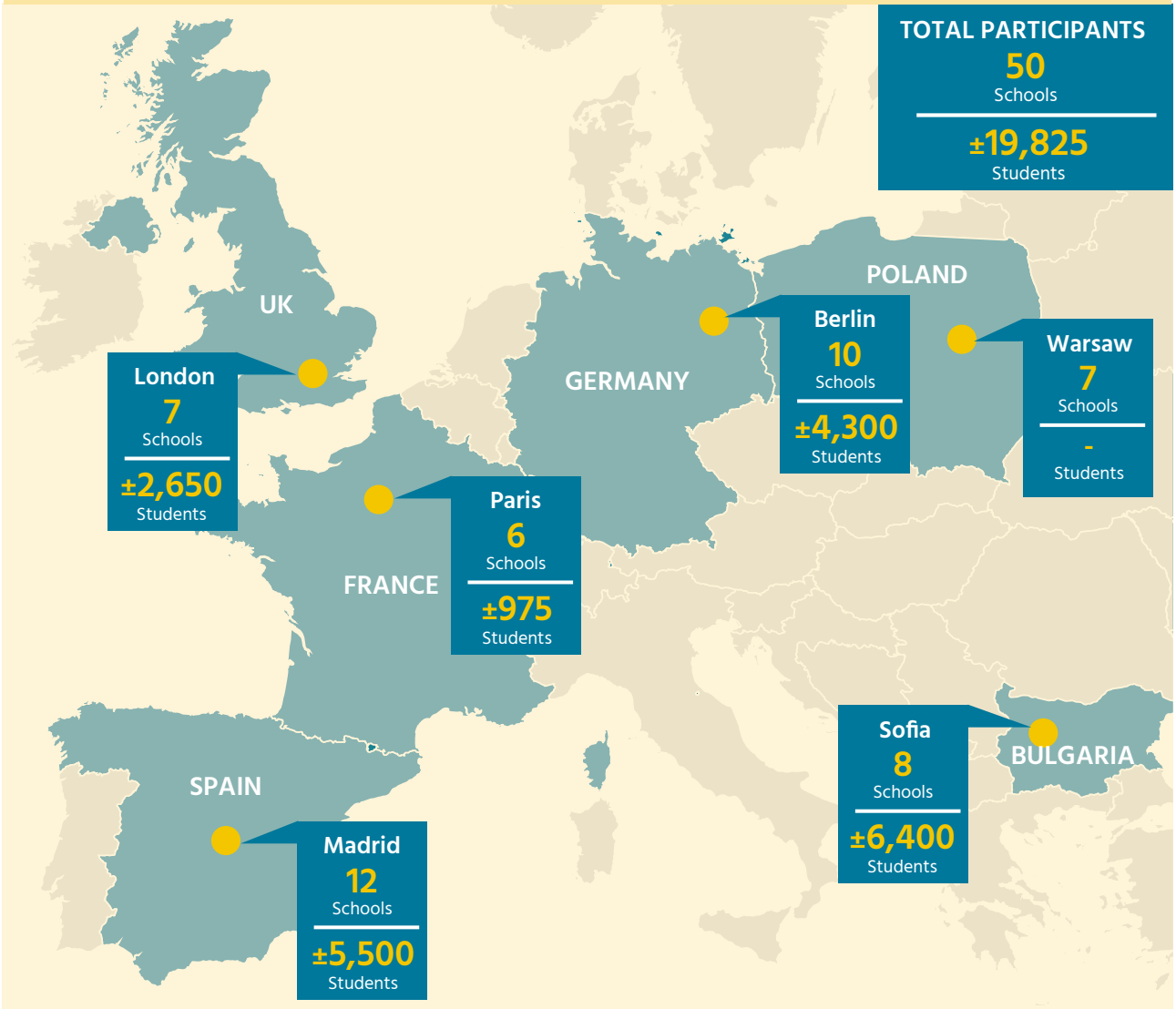
Findings of the HEAL snapshot – Indoor and outdoor monitoring at schools in six countries/capital cities in Europe

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 can be found in the respective city sections further in this report.

Common findings

- At all participating schools, NO_2 was detected inside the classrooms. As there were no sources of NO_2 in classrooms, these NO_2 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 CO_2 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.

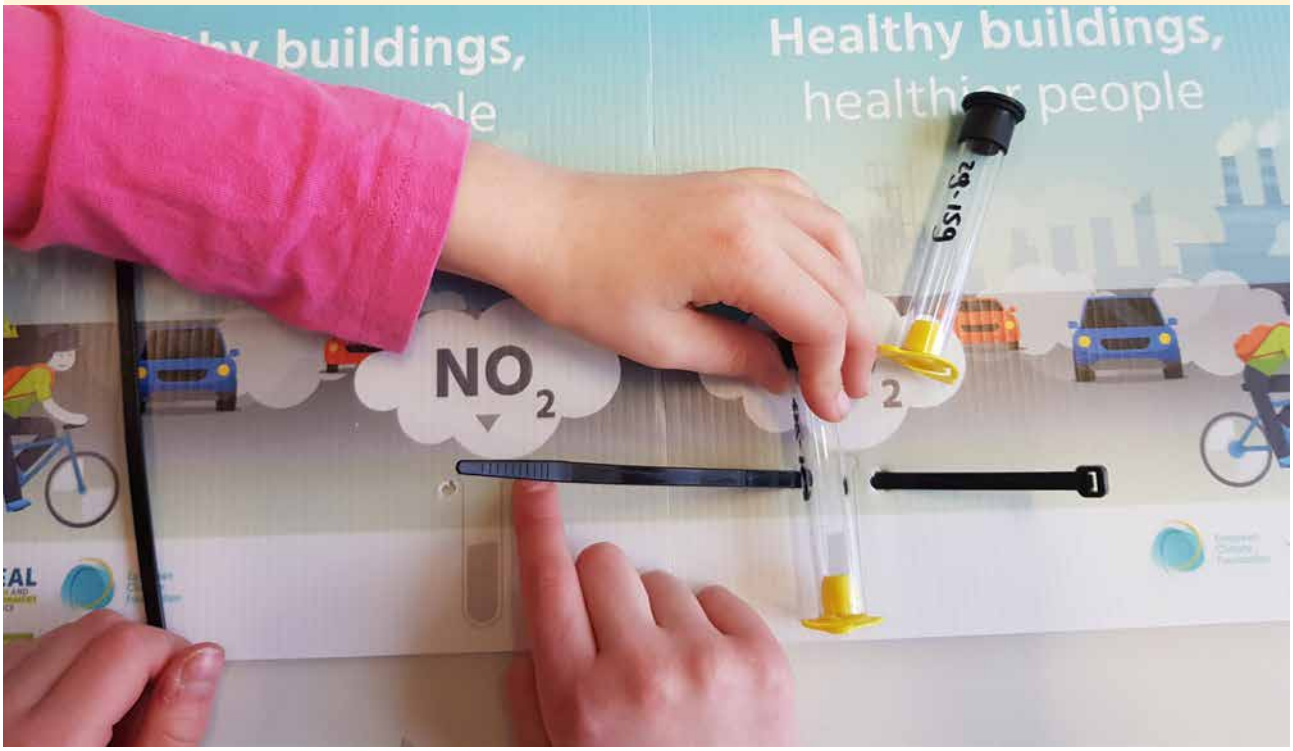
The variation in the results can be explained by many factors, including proximity to busy roads, the season and characteristics of the building. Understanding how these interact is complex. However, the results do clearly demonstrate that outdoor pollutants enter school buildings and influence indoor 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.

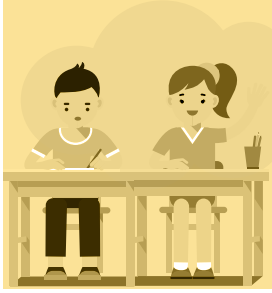
The indoor environment cannot be separated from the outside world. The high values of CO_2 observed in a majority of the classrooms

▶ CEIP Ignacio Zuloaga, Madrid, pupils use the CO_2 monitor. | © AEEA |

underlines the need for ventilation. To prevent drowsiness, loss of concentration, and decreased productivity, it is important to ventilate regularly. 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 |



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Traffic pollutes schools and threatens children's health

Spain has exceeded the EU air quality standards, especially in the cities of Madrid and Barcelona, and was threatened to be brought to court by the European Commission in 2017[10]. Madrid is one of the European regions most polluted capitals and traffic is responsible for around half of the emissions of NO_2 and PM. Diesel vehicles combined with frequent dry climate conditions contribute to high NO_2 levels.

Researchers have found that, based on air quality data, the amount of particles entering citizens' lungs while breathing is equivalent to smoking 2-3 cigarettes a day in some districts of Madrid[11]. In order to tackle the air pollution problem, the city of Madrid enforced a zero emissions zone in November 2018, called Madrid Central. Only zero emissions vehicles and residents have authorisation to drive in this area. It has been reported that this area has seen a 40% reduction in NO_2 since the introduction[12].

Summary

▶ Map caption: Geographical locations of the schools across Madrid

- 12 primary schools in Madrid[1]
- Covering ten out of 21 districts in Madrid, every social and economic status
- The centre of the city is fully represented, except for the districts of Retiro and Chamartín
- School population represented: ± 5,500 children and ± 300 children inside the participating classrooms
- Two schools were within 1km of a motorway, three other schools were surrounded by big streets and one near an A-road and one near a highway tunnel. The remaining four were not within 500m of a busy road or highway
- The majority of schools said that children mainly walked to school.

[1] *Participating schools were CEIP Amador de los Ríos, CEIP Ignacio Zuloaga, CEIP Rufino Blanco, CEIP Ermita del Santo, CEIP San Ildefonso, CEIP Concepción Arenal, CEIP Eduardo Rojo, CEIP El Quijote, the other schools wished to remain anonymous.*

Results

12 primary schools participated in the project in Madrid. The NO_2 concentration in and around the schools was generally high during the weeks of the monitoring. At one school close to heavy traffic, the NO_2 value at the school entrance was 43 µg/m³. This monthly average is higher than the annual EU and WHO air quality standards. Since the values measured are averages, the NO_2 concentration will probably have been significantly higher during certain periods of the monitoring. During the night and the weekends there will have been lower concentrations as there is less traffic during these times. Three other schools had NO_2 measurements at the school entrances between 34 and 39 µg/m³. It is likely that at these schools the NO_2 concentration also exceeded 40 µg/m³ during school hours. Indoors, NO_2 concentrations as high as 35 µg/m³ were observed, indicating that outdoor air pollutants enter the school building and the classroom.

The CO_2 monitoring in the classrooms showed that only one classroom had a concentration below 1,000 ppm. Two classrooms even had concentrations higher than 3,000 ppm, out of the range of the measuring device. Discussions with the teachers indicated that ventilation is often a dilemma as street air quality is poor and there are also energy efficiency considerations, for example losing heat in winter and keeping cool in summer.

▶ School children hang up the NO_2 monitoring tubes at CEIP Ignacio Zuloaga | © AEEA |

Schools	NO_2 outdoors (µg/m³) *Measured over a four-week period*	NO_2 indoors (µg/m³) *Measured over a four-week period*	$PM_{2.5}$ outdoors (µg/m³) *Measured over a single 20-minute period*	$PM_{2.5}$ indoors (µg/m³) *Measured over a single 20-minute period*	PM_{10} outdoors (µg/m³) *Measured over a single 20-minute period*	PM_{10} indoors (µg/m³) *Measured over a single 20-minute period*	CO_2 (ppm) *Maximum value measured over a single 20-minute period*
Madrid school 1*	-	-	5	4	6	6	1395
Madrid school 2	43	33	12	3	16	3	1540
Madrid school 3	21	10	3	2	3	3	>3000
Madrid school 4	27	18	13	4	17	5	1515
Madrid school 5	39	15	5	1	6	2	1835
Madrid school 6	29	21	5	5	6	7	1800
Madrid school 7	20	30	8	2	10	3	950
Madrid school 8	34	35	6	4	7	4	1385
Madrid school 9	26	17	3	2	4	3	1840
Madrid school 10	37	22	6	2	7	2	1800
Madrid school 11	26	18	3	9	4	11	2000
Madrid school 12	26	27	5	3	3	7	>3000

* Unfortunately, the NO_2 tubes of Madrid school 1 were lost and are missing from the analysis.

Conclusions and Recommendations for Madrid

The high values of NO_2 at the schools in Madrid underline the traffic-related air pollution issue in the city. These results show that traffic related pollution does not exclusively impact outdoor air but also influences the air quality indoors, where children who are more vulnerable to the negative health impacts, go to learn and play.

In order to tackle air pollution and have clean, healthy air, the following recommendations should be implemented in Madrid:

1. **Make tackling air pollution in schools and other children's environments a political priority.**
2. **Maintain and expand the Madrid Central low traffic area in the centre of the city.**
3. **Create a safe and extensive network of cycling lanes as demanded by civil society, such as the 2021 project[2].**

Walter Post, teacher at from CEIP Ignacio Zuloaga, one of the 12 schools who actively participated in this monitoring project said: *"Not even classrooms, where boys and girls spend part of their lives, are free of air pollution caused by human activities. It is necessary, imperative, to protect them, protect ourselves, and live in healthy environments."*

[2] *For more information see website of Pedalibre: https://pedalibre.org/2018/11/26/por-una-red-ciclista-para-2021/*

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About

This report is by the Health and Environment Alliance (HEAL). It was researched and written by:

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AEEA is an open, scientific, non-profit association, formed by 200 individuals, associations, companies and institutions working in the field of environmental education. Its objective is to promote education as the key to ensure Sustainable Development and the improvement of the quality of life in our planet. AEEA's members aim to help people develop a comprehensive knowledge about the environment, which will lead them to understand its functioning and the problems triggered as a result of an inadequate development model, with an intend to minimize the current environmental problems, and prevent others that may arise in the future.

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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.

MADRID

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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