

# LONDON

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## Healthy air, healthier children

Reduce traffic pollution to clean up  
schools indoor environments



**HEAL**  
HEALTH AND  
ENVIRONMENT  
ALLIANCE

## Summary

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### 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 globally<sup>1</sup>. 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<sup>2</sup>. Each year, air pollution causes around 400,000 premature deaths and hundreds of billions of euros in health costs in the EU alone<sup>3</sup>.

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<sup>4</sup>.

In cities, emissions from cars, buses and lorries are a major contributor to poor air quality, in particular emissions of nitrogen dioxide (NO<sub>2</sub>). NO<sub>2</sub> 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<sub>2</sub> can lead to asthma and make health problems of asthmatic people worse. Researchers are also investigating a possible link between NO<sub>2</sub> and heart disease and diabetes<sup>5</sup>.

### Children and air pollution



Even more worrying is evidence of the toll it takes on children<sup>6</sup>. 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<sup>7,4</sup>.

## HEAL's project



► NO<sub>2</sub> monitoring tubes outside a Berlin school | © HEAL |

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<sub>2</sub>); Spain is breaching both NO<sub>2</sub> 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<sup>8</sup>.

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<sup>4</sup>. 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<sub>2</sub> 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 CO<sub>2</sub> 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<sub>2.5</sub> and PM<sub>10</sub>, the number indicating the size of the particles.
- Nitrogen Dioxide (NO<sub>2</sub>). NO<sub>2</sub> 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<sub>2</sub>) measured inside the classroom. CO<sub>2</sub> acts as an indicator of indoor air quality and ventilation. Inside CO<sub>2</sub> levels can rise high enough to cause drowsiness, affecting concentration and productivity<sup>9</sup>.

This report uses a limit value of 1,000 part per million (ppm) for CO<sub>2</sub> 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<sub>2</sub>:

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

\* 99<sup>th</sup> 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 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 of its kind to use a coordinated, citizen-science approach to measure both indoor and outdoor pollutants to date in Europe.

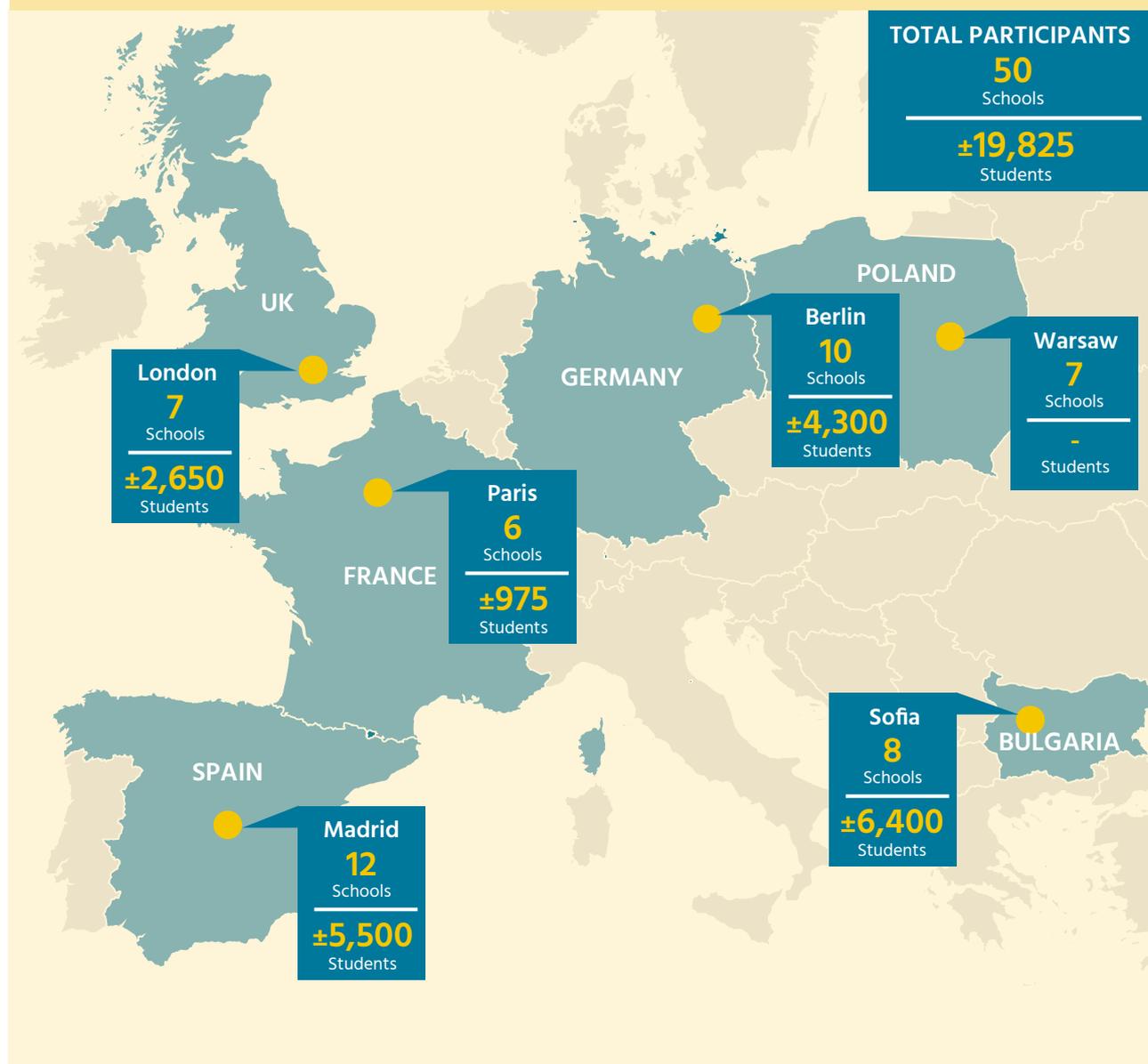
## Findings of the HEAL snapshot – Indoor and outdoor monitoring at schools in six capital cities in Europe

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

### Common findings

- At all participating schools, NO<sub>2</sub> was detected inside the classrooms. As there were no sources of NO<sub>2</sub> in classrooms, these NO<sub>2</sub> 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<sub>2</sub> 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  $\text{NO}_2$ , 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  $\text{NO}_2$  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  $\text{CO}_2$  observed in a majority of the classrooms



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

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 ( $\text{NO}_2$ ) in the classroom | © HEAL |



Air quality in London has been of concern for both the public and policymakers. In 2016, two million people in London breathed polluted air, of which 400,000 were children<sup>10</sup>. The UK has the highest prevalence of childhood asthma among all European countries<sup>11</sup>.

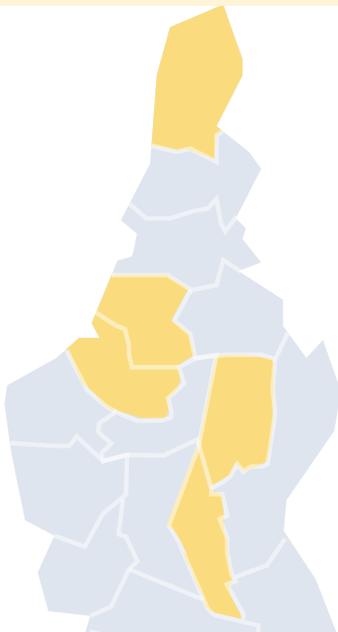
London exceeds EU NO<sub>2</sub> air standards, with half of emissions coming from road traffic<sup>12</sup>. The borough of Lambeth, where the schools monitored in this project are located, is ranked as one of the worst polluted boroughs in the city<sup>13</sup>.

Public Health England published a review of interventions to improve outdoor air quality

and public health in 2019<sup>14</sup>. The Mayor of London commissioned an indoor air quality audit among 50 primary schools and a study which found that PM concentrations in most classrooms were above WHO guidelines. It also indicated that limiting CO<sub>2</sub> to between 600 and 1,000 ppm may improve cognitive performance of students<sup>11</sup>.

In order to protect Londoner's health, a new Ultra Low Emission Zone came into effect in spring 2019, charging diesel and petrol vehicles if they fail to meet new emission standards. This zone is set to be expanded further in 2021<sup>12</sup>.

## Summary



- Seven public primary schools in Lambeth, London<sup>1</sup>
- School population represented: ± 2,650 pupils
- One school is exposed to a main central London road and has installed a green screen - a wall of plants - to better protect the playground from traffic. Two schools are set 50m back from main roads and have wildlife gardens surrounding the playground. Two schools are on quieter side roads with busy periods at drop-off time.

► Geographical location of the schools across Lambeth, London

<sup>1</sup> Participating schools were Hitherfield Primary School and Children's Centre, Allen Edward Primary School, Oasis Academy Johanna and Lark Hall Primary School, the other schools wished to remain anonymous.

## Results

Seven schools participated in the initiative in London. In each classroom, the results show NO<sub>2</sub> concentrations of at least 12 µg/m<sup>3</sup> to up to 26 µg/m<sup>3</sup>. This is remarkable as there are no indoor sources of NO<sub>2</sub> in classrooms, meaning that outdoor NO<sub>2</sub> pollutants travelled indoors to classrooms. Outdoors the values ranged from 25 to 41 µg/m<sup>3</sup>. It is important to note that the results of the NO<sub>2</sub> monitoring are averages and will likely have been higher during school hours and drop-off times due to higher traffic volumes compared to evenings and weekends.

In all the classrooms the CO<sub>2</sub> concentrations were well above 1,000 ppm, ranging from 1195 ppm to as high as 2750 ppm. This indicates that there is a need for more ventilation. Ventilation is essential to indoor air quality as it dilutes the level of pollution. Poor ventilation rates inside schools may cause asthma, dizziness, inability to concentrate, headaches and irritated throat - amongst other symptoms<sup>15</sup>.



► Hitherfield Primary School Eco Group helped with the NO<sub>2</sub> monitoring. | © Sustrans |

| Schools           | NO <sub>2</sub> outdoors (µg/m <sup>3</sup> )<br><i>Measured over a four-week period</i> | NO <sub>2</sub> indoors (µg/m <sup>3</sup> )<br><i>Measured over a four-week period</i> | PM <sub>2.5</sub> outdoors (µg/m <sup>3</sup> )<br><i>Measured over a single 20-minute period</i> | PM <sub>2.5</sub> indoors (µg/m <sup>3</sup> )<br><i>Measured over a single 20-minute period</i> | PM <sub>10</sub> outdoors (µg/m <sup>3</sup> )<br><i>Measured over a single 20-minute period</i> | PM <sub>10</sub> indoors (µg/m <sup>3</sup> )<br><i>Measured over a single 20-minute period</i> | CO <sub>2</sub> (ppm)<br><i>Maximum value measured over a single 20-minute period</i> |
|-------------------|--|---|---|--|--|---|---|
| London school 1*  | 26/36  | 26/36   | 2   | 3  | 2  | 4   | 2000  |
| London school 2   | 25   | 15  | 5   | 1  | 6  | 1   | 1250  |
| London school 3   | 29   | 17  | 17  | 5  | 25   | 6   | 2520  |
| London school 4   | 29   | 20  | 3   | 2  | 3  | 3   | 2750  |
| London school 5** | -  | -   | 0   | 1  | 1  | 1   | 1645  |
| London school 6*  | 12/35  | 12/35   | 2   | 0  | 1  | 3   | 1195  |
| London school 7   | 30   | 17  | 1   | 1  | 1  | 1   | 1395  |

\* Technical problem that prevented determining if value was outside or inside, both results are given. However, it is likely that the higher value was outdoors.

\*\* Unfortunately, the tubes from school 5 were lost and are missing from the analysis.

## Conclusions and Recommendations for London

The relatively high levels of NO<sub>2</sub> inside the classrooms in London show that air pollution travels indoors. Traffic related air pollution does not remain confined to the roads but enters places where children spend the majority of their time. Children at school should not be exposed to these levels of air pollution as they are especially vulnerable to its negative health effects since their bodies are still developing.

The high concentrations of CO<sub>2</sub> inside the classrooms show there is a need for ventilation. Yet as long as the outdoor air poses a risk to health, children are not protected while at school.

The following actions should be followed to reduce air pollution in London and protect health:

- 1** School and local authorities should discourage and restrict traffic and car idling around schools, for example by implementing School Streets, where immediate streets around the school gates are closed to cars during the school run to reduce car emissions. Sustrans, the UK walking and cycling charity, has recently organised School Streets with 40 schools across the UK, to inspire action. Central governments are urged to give all councils the same powers the councils in London have to enforce School Streets.
- 2** Local authorities should establish free public transportation, powered by renewables and encourage walking and cycling. The UK government needs to show leadership by helping local authorities fund and deliver a network of walking and cycling routes to school so that every child is able to travel by foot or by bike to school safely and with confidence.
- 3** Further citizen science monitoring projects like the one performed in the seven schools in the Lambeth borough should be encouraged, to raise local awareness and engagement in tackling poor indoor and outdoor air quality. This is also an opportunity to teach children about the health effects of air pollution and what can be done to improve air quality.



**Yvonne Morris from Hitherfield Primary School and Children's Centre, one of the seven schools that actively participated in this monitoring project said:** "We take air quality very seriously in our school, as we want to provide the best environment we can for our children inside and outside the school. It was very interesting to monitor the pollution, particularly inside the school. Before we started the project, we didn't really know much about nitrogen dioxide, the fact it might travel into the buildings and how harmful that could be."

## Sources

1. World Health Organization (2016), Ambient air pollution: a global assessment of exposure and burden of disease, <https://apps.who.int/iris/bitstream/handle/10665/250141/9789241511353-eng.pdf?sequence=1>
2. World Health Organization, Ambient (outdoor) air quality and health, [https://www.who.int/news-room/fact-sheets/detail/ambient-\(outdoor\)-air-quality-and-health](https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health)
3. European Court of Auditors (2018), Air pollution: our health still insufficiently protected, <http://publications.europa.eu/webpub/eca/special-reports/air-quality-23-2018/en/>
4. Health and Environment Alliance (2018), HEAL's eight demands for clean air in the European Region, [https://www.env-health.org/IMG/pdf/180212\\_heal\\_8\\_demands\\_for\\_clean\\_air\\_in\\_euro\\_region\\_final.pdf](https://www.env-health.org/IMG/pdf/180212_heal_8_demands_for_clean_air_in_euro_region_final.pdf)
5. European Respiratory Society and International Society for Environmental Epidemiology (2019), The Health Impact of Air Pollution, <https://ers.app.box.com/s/81rilw1uyrj8kv24caowsy2hf7dv8nuz>
6. World Health Organization Regional Office for Europe (2016), WHO Expert Consultation: Available evidence for the future update of the WHO Global Air Quality Guidelines (AQGs), [http://www.euro.who.int/\\_\\_data/assets/pdf\\_file/0013/301720/Evidence-future-update-AQGs-mtg-report-Bonn-sept-oct-15.pdf?ua=1](http://www.euro.who.int/__data/assets/pdf_file/0013/301720/Evidence-future-update-AQGs-mtg-report-Bonn-sept-oct-15.pdf?ua=1)
7. Europe Beyond Coal (2019), Chronic coal pollution: EU action on the Western Balkans will improve health and economies across Europe, <https://www.env-health.org/wp-content/uploads/2019/02/Chronic-Coal-Pollution-report.pdf>
8. European Commission (2017), Commission warns Germany, France, Spain, Italy and the United Kingdom of continued air pollution breaches, [http://europa.eu/rapid/press-release\\_IP-17-238\\_en.htm](http://europa.eu/rapid/press-release_IP-17-238_en.htm)
9. Royal College of Physicians (2016), Every breath we take: the lifelong impact of air pollution. Report of a working party. <https://www.rcplondon.ac.uk/projects/outputs/every-breath-we-take-lifelong-impact-air-pollution>
10. David Carrington, The Guardian (2019), Air Pollution falling in London but millions still exposed, <https://www.theguardian.com/environment/2019/apr/01/air-pollution-falling-london-millions-still-exposed>
11. Mumovic, D. et al., Indoor Air Quality in London's Schools, [https://www.london.gov.uk/sites/default/files/gla\\_iaq\\_report\\_with\\_nts.pdf](https://www.london.gov.uk/sites/default/files/gla_iaq_report_with_nts.pdf)
12. Sustrans (2019), Sustrans welcomes launch of Ultra Low Emission Zone in London, <https://www.sustrans.org.uk/news/sustrans-welcomes-launch-ultra-low-emission-zone-london>
13. Greater London Authority (2013), Air quality in Lambeth, a guide for public health professionals, [https://www.london.gov.uk/sites/default/files/air\\_quality\\_for\\_public\\_health\\_professionals\\_-\\_lb\\_lambeth.pdf](https://www.london.gov.uk/sites/default/files/air_quality_for_public_health_professionals_-_lb_lambeth.pdf)
14. Public Health England (2019) Review of interventions to improve outdoor air quality and public health [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/795185/Review\\_of\\_interventions\\_to\\_improve\\_air\\_quality.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/795185/Review_of_interventions_to_improve_air_quality.pdf)
15. European Commission's Directorate General for Health and Consumers and the Joint Research Centre (2014), SINPHONIE: Schools Indoor Pollution & Health Observatory Network in Europe - final report, <http://publications.jrc.ec.europa.eu/repository/bitstream/JRC91160/lbna26738enn.pdf>

## About

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

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Sustrans is the UK charity making it easier for people to walk and cycle. Sustrans connects people and places, creates liveable neighbourhoods, transforms the school run and delivers a happier, healthier commute. [www.sustrans.org.uk](http://www.sustrans.org.uk)



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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.

# LONDON

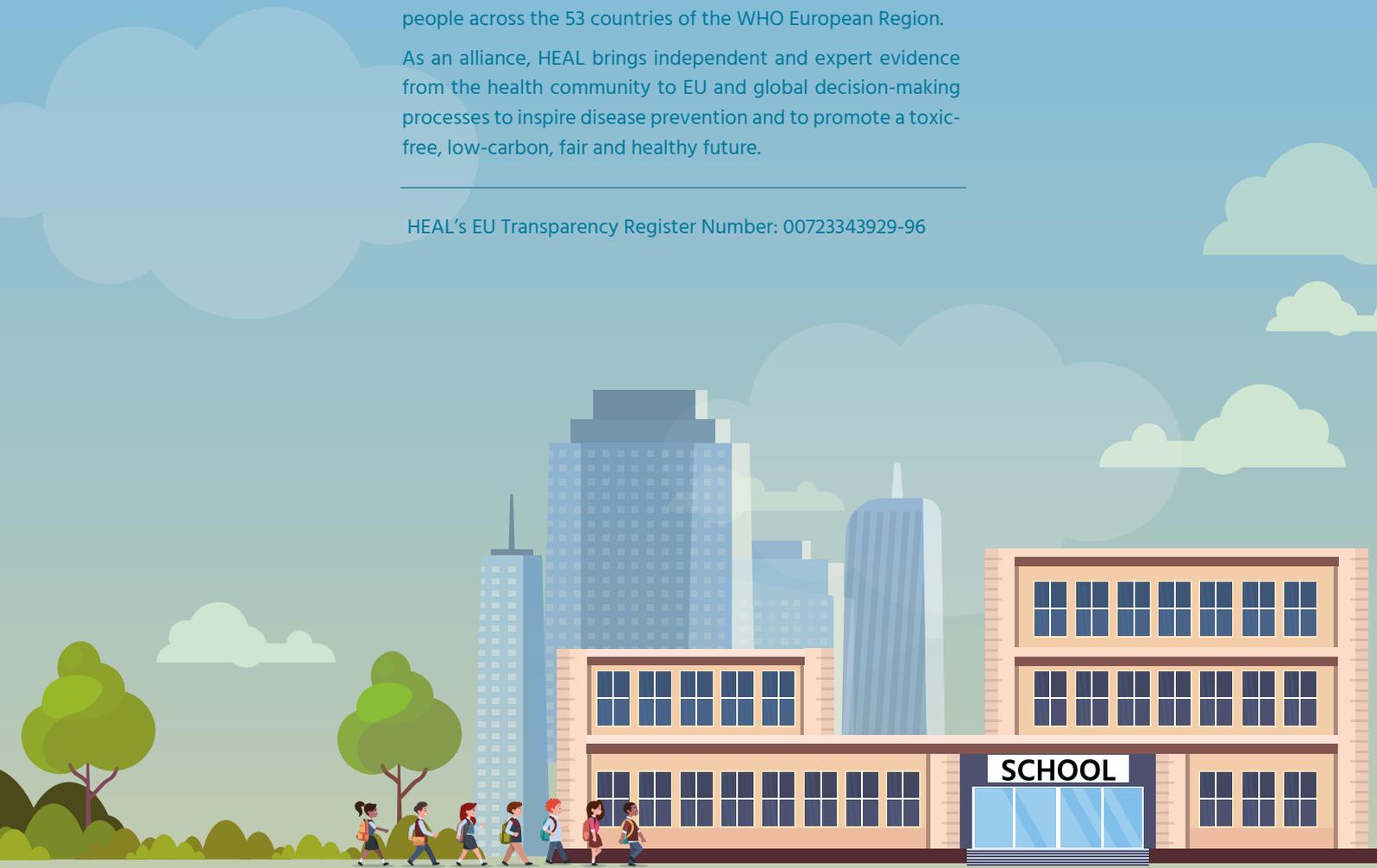
**The Health and Environment Alliance (HEAL)** is the leading not-for-profit organisation addressing how the environment affects human health in the European Union (EU) and beyond. HEAL works to shape laws and policies that promote planetary and human health and protect those most affected by pollution,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