

**URBAN95** 



# **Air quality in early childhood**



**Bernard  
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Harmful effects of air pollution on children's health and actions to minimise them.

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## WHAT IS AIR POLLUTION?

The air we breathe contains a mixture of gases, particles and substances essential for the maintenance of life on the planet. However, when there is an excess of substances to a level that is harmful to human health and the environment, we can consider that the air is polluted<sup>1</sup>.

In big cities, air pollution has been one of the main environmental problems. Increasing urbanisation, intensive industrialisation, excess of vehicles, the burning of waste, emissions from garbage, vegetation fires, among other issues, make the concentration of pollutants in the atmosphere harmful and contribute to the degradation of air quality, with impacts not only on a local scale but also regionally and globally<sup>2,3</sup>.

# WHAT ARE THE MAIN AIR POLLUTANTS?

In the air, in addition to gaseous pollutants, there are microscopic particles of various sizes formed by several chemical elements. The smaller and finer particles are the most harmful to human health due to their ease of inhalation and the risk they pose to the respiratory and cardiovascular system<sup>4</sup>. Currently, the main pollutants monitored by environmental agencies worldwide are:

- fine inhalable particulate matters (PM<sub>2.5</sub>)
- inhalable particulate matter (PM<sub>10</sub>)
- hydrocarbons (HC)
- carbon monoxide (CO)
- nitrogen monoxide, nitrogen dioxide (NO, NO<sub>2</sub>)
- ozone (O<sub>3</sub>).

The size of PM<sub>2.5</sub> can be equivalent to 20 times smaller than the thickness of a strand of hair, but there are even smaller particles, called ultrafines. The smaller the particle size, the more likely the pollutant is to penetrate deeply into the respiratory tract, which can cause various health problems in the short and long term<sup>5</sup>.

# WHERE DOES AIR POLLUTION COME FROM?

Air pollution can come from natural sources such as surface dust, sea salt and volcanoes, or from human activities such as industries and vehicles. In cities, several sources of pollution are present in our daily lives: vehicle engines, chimneys from industries such as steel mills, refineries, cement and paper factories, burning and incineration of household waste, dust rising from the ground and roads, wood ovens, cigarette smoke, and evaporation of cleaning chemicals, among others.





# AIR QUALITY AND SUSTAINABLE DEVELOPMENT GOALS

In 2015, the United Nations established a new sustainable development agenda and its member countries adopted 17 Sustainable Development Goals (SDGs) to stimulate action by 2030<sup>6</sup>. Atmospheric pollution, despite not being directly mentioned, is indirectly and transversally implicit in all the SDGs. Public policies to reduce the emission of pollutants and improve air quality contribute to achieving the SDGs.



**Goal 1:** Reducing air pollution can help families become healthier, save on medical expenses and improve their productivity.



**Goal 2:** Air pollution can damage harvests and affect the safety and quality of food.



**Goal 3:** Air pollution poses a major threat to human health. It is directly linked to respiratory infections and cardiovascular diseases. It causes an increase in the population's morbidity and mortality.



**Goal 4:** Air pollution can impact children's cognition and learning. It is important to ensure good air quality in schools and to teach about sustainable development policies.



**Goal 5:** Air pollution can directly affect the health of pregnant women and their babies, increasing the burden of care responsibilities that are often attributed only to females.



**Goal 6:** Pollutants from burning biomass and fossil fuels can cause acid rain and affect water quality.



**Goal 7:** Electricity from renewable sources generates benefits to public health through the reduction of air pollution.



**Goal 8:** Air pollution can have impacts on human health, crops, forest growth, climate and the environment, with consequences for productivity and economic growth.



**Goal 9:** Reducing energy consumption, and encouraging sustainable working practices and public transport can help improve air quality.



**Goal 10:** People in poverty and minority populations are more exposed to air pollution and are more vulnerable to adverse health impacts.



**Goal 11:** Large urban centres have many sources of pollutants. Encouraging more sustainable city planning can help reduce emissions.



**Goal 12:** Chemicals released into the atmosphere are dangerous to human health. Responsible production and consumption can help reduce this environmental problem.



**Goal 13:** Fossil fuels play an important role in climate change, putting at risk the quality of air, food and water supplies, and jeopardising human health.



**Goal 14:** The deposition of atmospheric pollutants in water can negatively affect its quality, leading to acidification and eutrophication which endanger aquatic life.



**Goal 15:** The emission of some pollutants derived from the combustion of fossil fuels can cause acid rain, which acts as a threat to forests and the ecosystem.



**Goal 16:** Public institutions have a fundamental role in air quality management, which must be monitored in order to develop efficient public policies to reduce air pollution.



**Goal 17:** There are no borders for air pollution, a problem that starts with local sources but has global impacts. Improving air quality must be addressed by all sectors and in all spheres of society.

# AIR POLLUTION AND ITS EFFECTS ON CHILDREN'S HEALTH

More than 7 million people die each year from cardiorespiratory diseases and lung cancer, illnesses directly related to air pollution<sup>8</sup>. Children breathe faster than adults and, as they are smaller, they are closer to the height of vehicle exhausts and surface dust, inhaling even more pollutants. Their lungs, brain and immune system are still developing, which makes children the section of the population that is most vulnerable to the effects of poor air quality – especially those up to 6 years old<sup>9,10</sup>.

Monitoring air quality in the environments where children spend most of their time, and developing strategies that minimise the effects of high concentrations of pollutants in these spaces, becomes vital to maintaining children's development and quality of life.

- Fine particulate matter (PM<sub>2.5</sub>) is the main pollutant associated with respiratory diseases. Even at low concentrations, **there is evidence of impacts on health**, especially for the most vulnerable such as children. **This has happened despite remaining within existing air quality guidelines<sup>11,12,13</sup>**, indicating that the standards may be inadequate.
- **Even before birth**, exposure to air pollution can affect the child, causing low birthweight, premature birth and impaired development of the immune system. Exposure to air pollution during pregnancy can also cause decreased lung function in childhood and susceptibility to bronchitis, rhinitis and childhood asthma<sup>14</sup>.
- Air pollution is also a risk for children's future. Few things are as important to a child as the first thousand days of life, a critical stage in brain and neurological development. Exposure to pollution can impact the healthy development of a child's brain, **given that the brain in the first few days of life is much more vulnerable to damage by airborne toxins than that of an adult<sup>15</sup>**.
- Exposure to air pollution (PM<sub>2.5</sub> and PM<sub>10</sub>) can significantly increase the prevalence of **childhood asthma and allergy, also affecting their learning and cognition<sup>5,8,16,17,18,19</sup>**.
- **Exposure to air pollution has been associated with the incidence of several childhood diseases**, such as cancer, otitis media, sickle cell anaemia, respiratory infections, obesity, atopic dermatitis, pneumonia, autism and rheumatologic diseases, among others<sup>10</sup>.

The World Health Organization (WHO) issues safety guidelines setting maximum limits of PM<sub>2.5</sub> and human exposure to it. However, studies show that children aged 12 and under have been hospitalised when levels were below these limits<sup>12</sup>. The exposure of children to high levels of pollution is also a social problem, as poorer populations reside in industrial areas or with less urban infrastructure and, therefore, they are more susceptible to poor air quality<sup>20,21</sup>.



### **PHYSICAL CHARACTERISTICS OF TODDLERS**

- They breathe 50% more air than adults per kilogram of body weight.
- Body tissues are immature and respiratory tract cells are more permeable because they are not fully developed.
- The lung will not be fully developed until the age of 6.
- The brain is in the main stage of development.
- The immune system is still maturing.
- Due to their short stature, they are closer to the level of vehicle exhausts and there is an accumulation of pollutants.

### **POLLUTION EFFECTS ON CHILDREN**

- Toxicity from inhalation of pollutants.
- Neural cell malformation.
- Low cognition and learning disabilities.
- Development of respiratory diseases such as asthma and bronchitis.

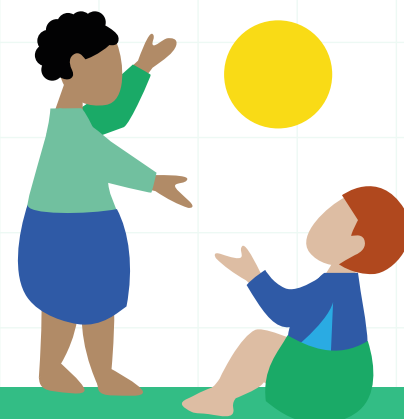
# AIR QUALITY IN EARLY CHILDHOOD SPACES



## School and its surroundings

The air quality in and around schools, where children can spend five hours or more a day, can influence their health. Urban school areas are surrounded by different sources of pollution. One of the main sources is the large number of vehicles at the school's entrance, where drivers usually form lines of cars idling while children are being dropped off or collected. Studies show that the concentration of fine particles (PM<sub>2.5</sub>) increases by 300% around the school during the periods of entry and exit of students<sup>22</sup>.

When parents drop off or pick up their children from schools by car, and leave the engine running, toddlers can be exposed to high levels of pollutants such as particulate matter, CO and NOX. Another factor that affects the increase in the concentration of pollutants in the school environment is the proximity of bus stops, roads with heavy traffic and intersections with traffic lights.



- School is where children usually spend the second-longest part of their day, so it is important that the air quality is favourable for healthy development.
- Students' arrival and departure times can represent the peak concentration of pollutants in and around schools, especially when there is a large number of idling vehicles or congestion.
- The concentration of pollutants is higher between ground level and 1 metre above, where vehicle exhaust emissions occur. Many schools have children's waiting areas close to arrival and departure points, which can cause the inhalation of more pollutants.
- Pollutant emissions from vehicles outside schools also affect concentrations of fine particles inside them.
- It is important to keep the indoor areas of schools well ventilated, and to prevent the entry of pollutants. Schools should give preference to ventilation facing the interior of the site and not outwards to roads with a high volume of vehicular traffic.
- Exposure to green spaces is beneficial for children's development and can be an ally in the fight against air pollution.

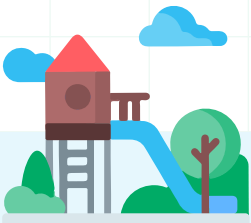




## Residential areas

Pollutant levels indoors can be as high as outdoors, even in highly industrialised cities. Many people spend 90% of their time indoors<sup>23</sup>. Gases and particles are the main cause of poor air quality inside homes. Inadequate ventilation can also increase indoor pollutant levels because it does not dilute indoor emissions or renew indoor air as often as necessary. Many people cook or heat their homes using open fires or simple stoves burning kerosene, biomass (firewood and agricultural residues) and charcoal<sup>24</sup>.

Other sources of indoor pollutants include construction and painting materials, chemicals and household cleaning products, air conditioning systems and cigarettes (which expose children to second-hand smoke). It is important to be aware of these sources of pollution to protect children's health inside the home<sup>15</sup>.



## Public spaces

Public spaces frequented by children and caregivers, such as parks, playgrounds and squares, are environments directly affected by emissions from vehicles, industries and local fires, depending on the characteristics of each city. The WHO recommendations for outdoor environments are to avoid outdoor activities and strenuous physical effort when the concentration of pollutants is high or above levels considered safe for health. Warnings and recommendations in these situations must be made by environmental agencies that monitor pollutants, such as CETESB in the state of São Paulo, Brazil<sup>25</sup>.

For children with pre-existing respiratory problems, such as asthma and bronchitis, these recommendations should be emphasised, and the use of masks in public spaces is recommended on days with high concentrations of pollutants<sup>15</sup>.







# AIR QUALITY STANDARDS: HOW DO YOU KNOW IF THE LEVELS ARE ACCEPTABLE?

In order to provide guidance on reducing the health impacts of air pollution, the WHO has established air quality standards based on the assessment of expert scientific evidence. From these recommendations, each country defines its own standards according to the health risks, technological feasibility, economic and other political and social factors in place. In Brazil, each state can establish its own standards, as long as they are equal to or more restrictive than the federal norm, which currently defines pollutant concentration limits far above those recommended by the WHO<sup>13,26</sup>.

Air quality monitoring in Brazil is as yet only carried out in a few states<sup>10,27</sup>. A study found that, of the 27 states, 20 do not conduct air quality monitoring, or do so inefficiently. The work is limited by the high costs and maintenance of the measuring and recording equipment<sup>28</sup>.

Public-service managers need to invest in air quality monitoring, even if it involves using alternative technologies, in order to identify the levels of pollutants to which the population – especially children – is exposed. This knowledge allows the development of strategies and actions to keep levels of pollutants within recommended standards and, in this way, to ensure people's health.

## AIR QUALITY MANAGEMENT FOR PUBLIC-SERVICE MANAGERS

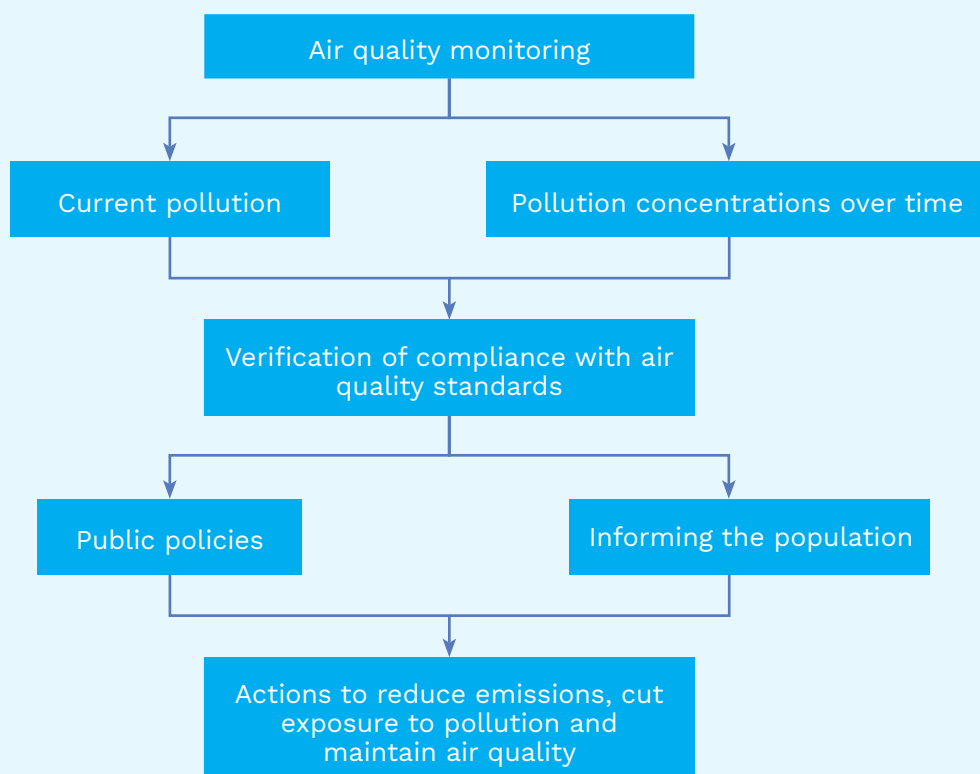


Table 1 presents the Brazilian air quality standards, separated into intermediate air quality, goals that will be established and implemented in stages, and the final standard, which reflects WHO guidelines<sup>13,26</sup>. The current standards are highlighted in bold. They show there is a still long way to go for the adoption of the final results, recommended by the WHO, aiming to protect the health of the population.

**Table 1.** National Air Quality Standards (CONAMA Resolution, No. 491, of November 19, 2018). Source: Adapted from BRASIL (2018)<sup>26</sup>.

Air Pollutant	Reference Period	Intermediate Standard 1 ( $\mu\text{g}/\text{m}^3$ ) Current Standard	Intermediate Standard 2 ( $\mu\text{g}/\text{m}^3$ )	Intermediate Standard 3 ( $\mu\text{g}/\text{m}^3$ )	Final Standard ( $\mu\text{g}/\text{m}^3$ ) WHO Guideline
Particulate Matter ( $\text{PM}_{10}$ )	24 hours Annual <sup>a</sup>	<b>120</b> <b>40</b>	100 35	75 30	45 15
Fine Particulate Matter ( $\text{PM}_{2.5}$ )	24 hours Annual <sup>a</sup>	<b>60</b> <b>20</b>	50 17	37 15	15 5
Sulphur dioxide ( $\text{SO}_2$ )	24 hours Annual <sup>a</sup>	<b>60</b> <b>40</b>	40 30	30 20	20 -
Nitrogen dioxide ( $\text{NO}_2$ )	1 hour <sup>b</sup> Annual <sup>a</sup>	<b>260</b> <b>60</b>	240 50	220 45	200 40
Ozone ( $\text{O}_3$ )	8 hours <sup>c</sup>	<b>140</b>	130	120	100
Smoke	24 hours Annual <sup>a</sup>	<b>120</b> <b>40</b>	100 35	75 30	50 20
Carbon Monoxide (CO)	8 hours <sup>c</sup>	-	-	-	9 (ppm)
Total Suspended Particles TSP	24 hours Annual <sup>d</sup>	- -	- -	- -	240 80
Lead (Pb)	Annual <sup>a</sup>	-	-	-	0.5

**Comments:**

- a. Annual arithmetic average
- b. Hourly average
- c. Maximum moving average achieved on the day
- d. Annual geometrical average



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## **POSSIBLE ACTIONS TO MINIMISE THE EFFECTS OF AIR POLLUTION ON CHILDREN AND SCHOOL SPACES**

**Everyone can help reduce** children's exposure to air pollution, minimise its effects on children's health and contribute to reducing sources of emissions in early childhood spaces at all levels, whether personal or collective, in the school community or public spheres.



## Municipal government actions

- Monitor air quality in real time and in places with a high presence of children.
- Develop mechanisms to inform the population about air quality levels and the precautions to be taken when the levels demonstrate a health risk.
- Design programmes and campaigns to raise awareness by parents and caregivers about poor air quality, its effects on children's health and development, and how to avoid exposure to air pollution.
- Encourage actions to replace fossil fuels with cleaner and renewable energy sources, including the proper use of solar, wind and thermal energy.
- Avoid the construction of schools for young children and public facilities in locations near roads with heavy vehicular traffic.
- Create quiet areas or 30 kph zones (areas with reduced vehicular speed) in parts of the city where there are many early childhood facilities.
- Encourage the construction of flowerbeds and green areas along very busy roads where there are already schools, facilities and public spaces used by young children
- Prevent bus stops and traffic lights from being installed in front of schools or very close to the access to schools in order keep serious pollution away from places frequented by children

## Collective actions

- Organise car-sharing groups with parents and caregivers to reduce the use of private vehicles.
- Talk to friends and family about the risks of air pollution to children's health, and share ideas for action in the community.
- Demand information from the government on monitoring the levels of air quality in places frequented by children.
- Support actions to create, maintain and protect green areas in the neighbourhood and in school spaces.

## School community actions

- Carry out activities with parents and children to raise awareness of the impacts of air pollution, identify sources of local pollution (such as burning rubbish) and the importance of actions to reduce exposure to pollution.
- Change or make flexible the start and end times of classes for young children, in order to reduce exposure to pollution at times when traffic is especially heavy.
- Support and organise a car-sharing system for children's caregivers and parents.
- Install hedging and green spaces between the employee car park and the entrance, and around windows, courtyards and other areas of the school.
- Establish pick-up and drop-off points farther away from the school gate to avoid a concentration of pollutants in places where many children gather. Also recommend that parents and caregivers walk with children to the school gate.
- Advise school vehicle drivers not to keep the engine running while waiting to pick up and drop off children.
- Keep rooms and indoor spaces ventilated, but avoid opening windows and doors that face roads with heavy traffic.

## Individual actions

- Wear a mask during periods when pollution levels are high, such as the rush hour on roads, or when indicated by environmental control agencies.
- Prioritise the use of active transport (on foot, bicycle).
- Do not burn rubbish.
- Do not smoke in the presence of children.
- Keep the home environment clean and wash blankets regularly.
- Keep children away from areas under renovation.
- Keep homes ventilated, but avoid opening windows that face places with heavy vehicular traffic.
- Be careful when using wood stoves and fireplaces indoors.
- Use certified cleaning products and use the dose indicated by the manufacturers.
- Regularly maintain the air conditioning.
- Avoid exposing children to environments where pollution is high, such as streets and avenues with heavy road traffic.

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