



MAPEC_LIFE
(LIFE12 ENV/IT/000614)

Monitoring air pollution effects on children
for supporting public health policy

Layman's Report





Air pollution

Air pollution is the major environmental risk to health in Europe. It causes premature death due to heart diseases, stroke, lung diseases and lung cancer and increases the incidence of a wide range of diseases (e.g. respiratory and cardiovascular diseases and cancer). Recently, the International Agency for Research

on Cancer (IARC) has classified air pollution as a whole, and particulate matter (PM) as a separate component, as carcinogenic to humans. However, European citizens are still exposed to concentrations of particulate matter exceeding the values proposed by the WHO.



+ BIG WORDS

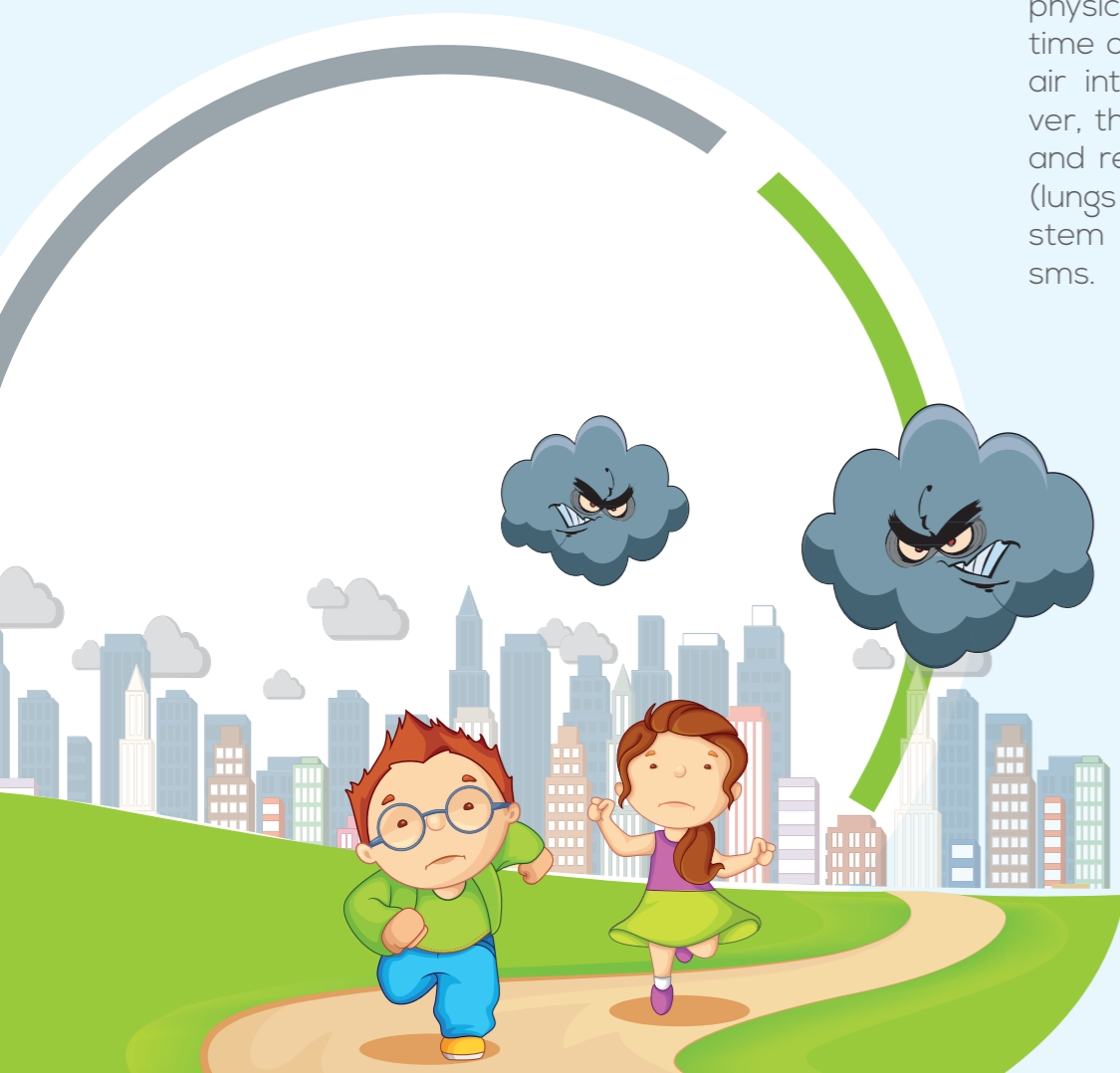
Particulate Matter (PM)

is microscopic solid and liquid matter suspended in the atmosphere. PM is classified by the particle's aerodynamic diameter (PM₁₀ = particles with diameter of 10 micrometers or less; PM_{0.5} = particles with diameter of 0.5 micrometers or less).



Children

Children are more vulnerable than adults to the effects of airborne agents, for several reasons. They have higher levels of physical activity, spend more time outside, and have a higher air intake than adults. Moreover, they have fast growth rate and relatively immature organs (lungs in particular), immune system and cell repair mechanisms.

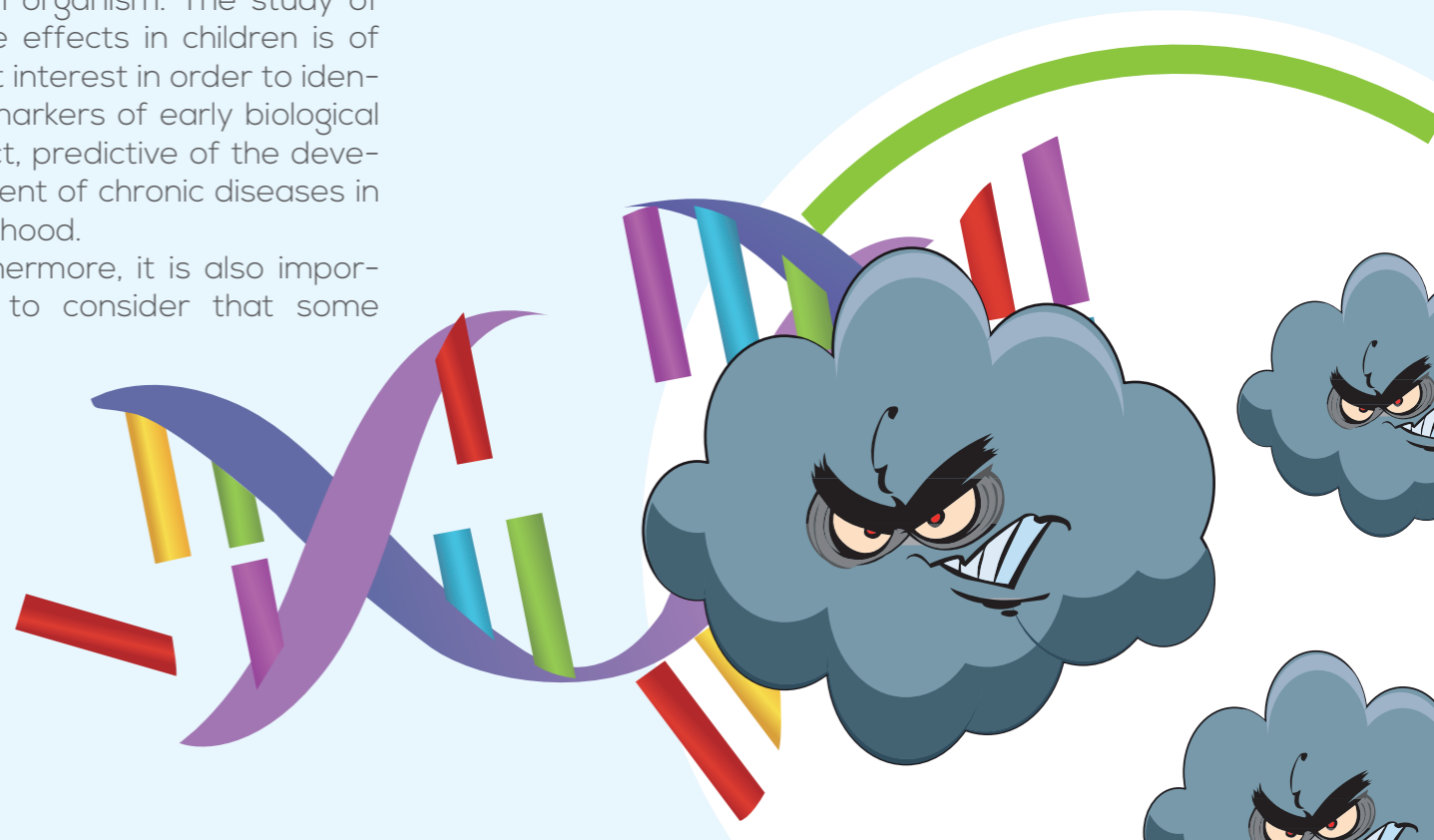


Early biological effects

Exposure to air pollutants has different consequences on human health. Many effects have been widely studied, while some others have to be further investigated, especially in children. It's the case of early biological effects, which indicate the ability of a substance to cause damage to the cells of an organism. The study of these effects in children is of great interest in order to identify markers of early biological effect, predictive of the development of chronic diseases in adulthood.

Furthermore, it is also important to consider that some

factors associated with lifestyle can influence air pollution effects by modulating the body's response. In particular, nutrition, physical activity and exposure to indoor pollutants (such as passive smoking) play an important role.



+ BIG WORDS

Early biological effects occur in the cells before the disease development.

Markers of early biological damage are those biological effects that predict the development of diseases.

Why?



To evaluate the presence of early biological effects, such as DNA damage in buccal cells of 6-8 year-old children in relation to:

- concentrations of some airborne pollutants;
- genotoxic activity of air particulate matter, measured by in vitro tests;
- socio-economic and demographic features, exposure to indoor pollutants and lifestyle factors of children.



To obtain an estimate of the risk of biological effects due to air pollutant exposure and other factors.



To provide information to guide actions and environmental policies aimed to protect children's health from air pollutant effects.

MAPEC_LIFE Project

(LIFE12 ENV/IT/000614)

Monitoring air pollution effects on children for supporting public health policy

The MAPEC_LIFE project was approved in 2013 by the European Commission and funded by the LIFE+ Program, the European Union's environment fund.



Where?

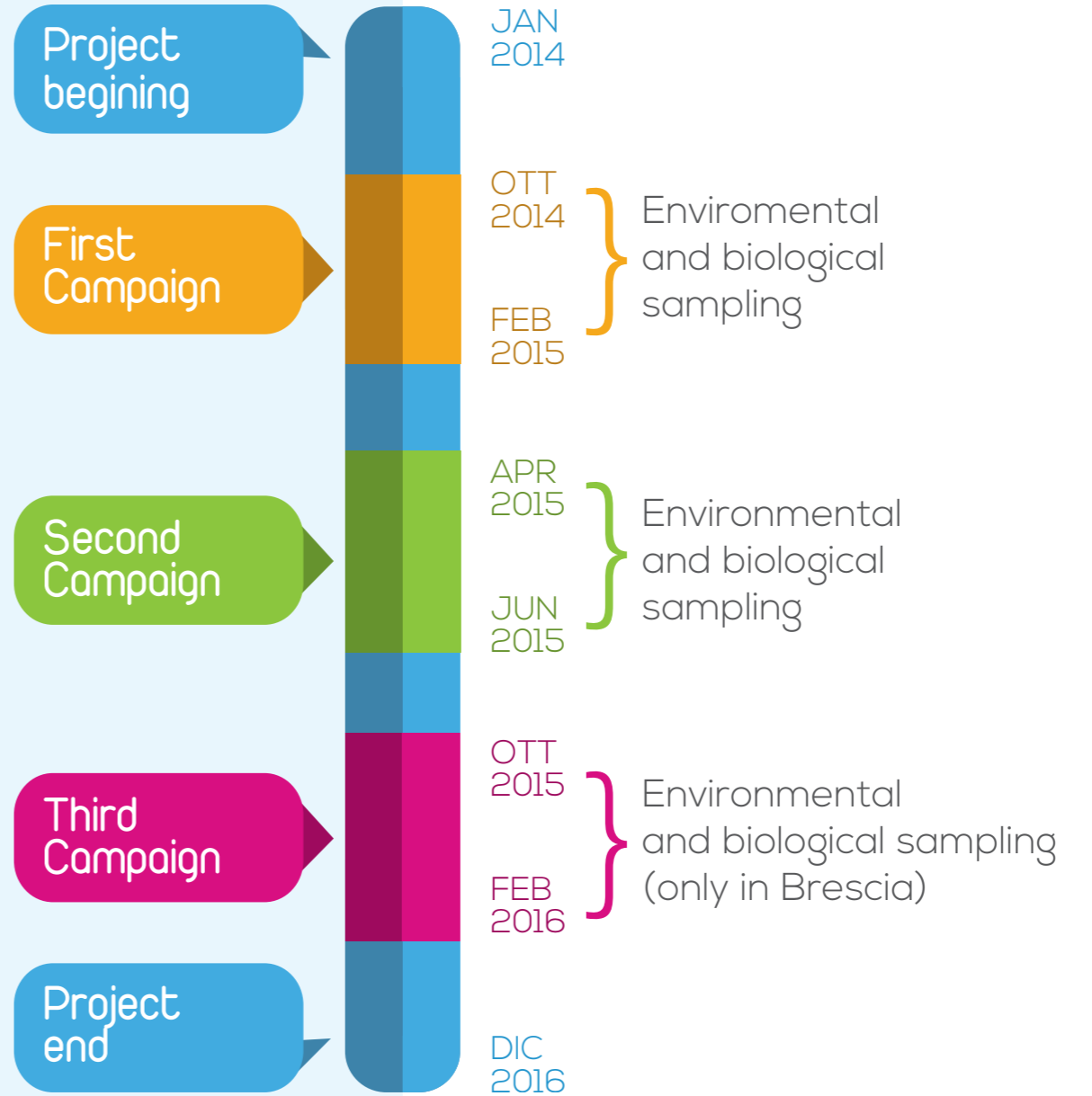
The MAPEC_LIFE project, a multicenter cohort study, was carried out in 5 Italian cities (Brescia, Lecce, Perugia, Pisa and Torino), with different levels of air pollution.



Who?

When?

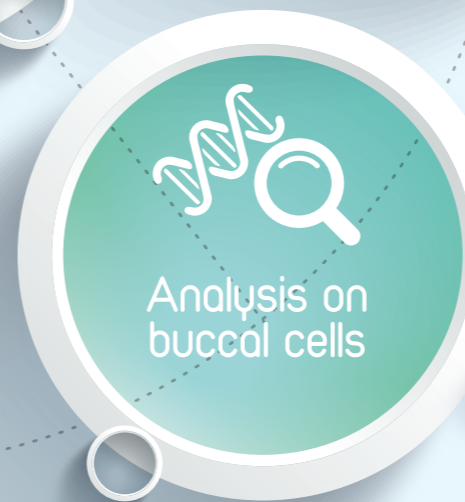
The project was coordinated by the University of Brescia and involved the University of Perugia, Pisa, Salento and Torino, the Municipality of Brescia and the Centro Servizi Multisetoriale e Tecnologico (CSMT Gestione) in Brescia.



How?

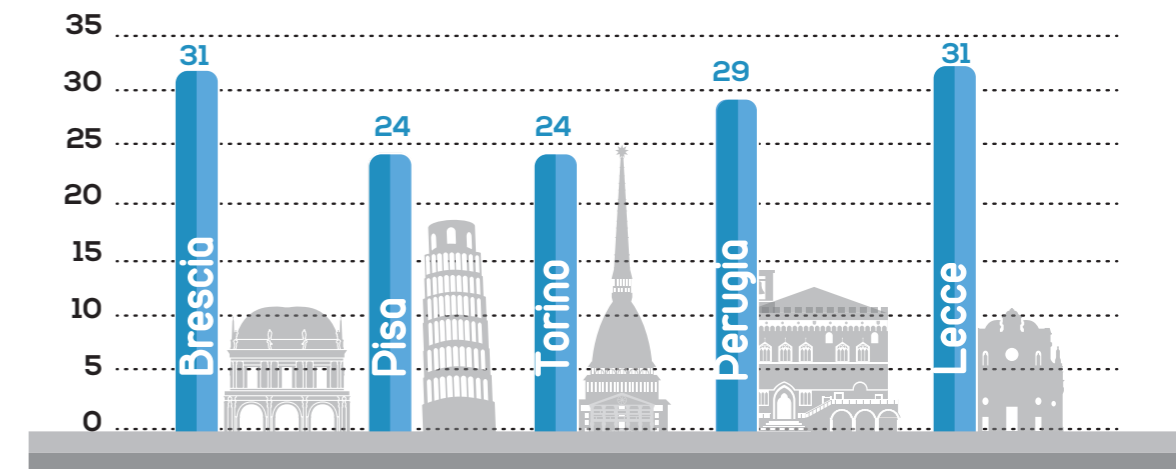
In order to achieve its objectives, the project considered various aspects:

1. **AIR QUALITY:**
assessment of the air quality the children were exposed to.
2. **QUESTIONNAIRES:**
collection of information on socio-demographic characteristics, indoor exposures and lifestyle factors of children.
3. **ANALYSIS ON BUCCAL CELLS:**
evaluation of the DNA damage in children's cells.
4. **EDUCATION:**
design and distribution of didactic tools for children and teachers.





SCHOOLS and CHILDREN



Class for each city

In each city, 4-6 schools (26 schools in total), located in the urban area, were identified with the help of local school authorities. The researchers, together with school managers, organized meetings with teachers and the children's parents in order to illustrate the project and promote participation in the study. About 250 6-8 year-old children were recruited in each city, for a total of 1.149 children in the entire study.

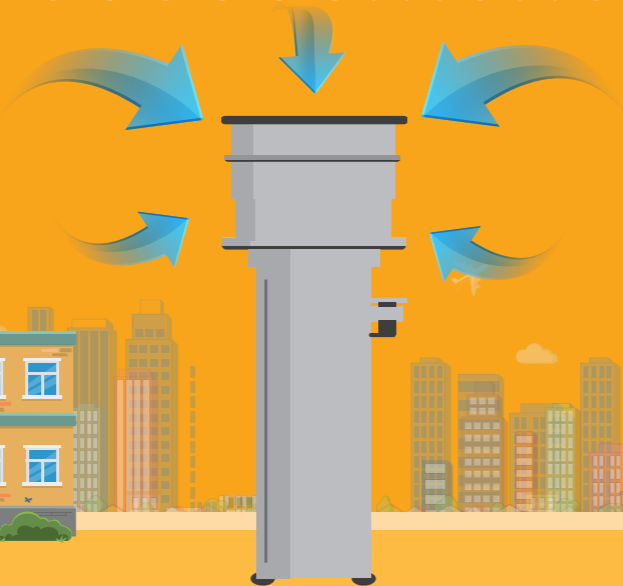


Before starting, the project was approved by the **local Ethics Committees of the 5 cities**.

All data were collected and analyzed in accordance with current regulations.



Air quality assessment



Collection of environmental samples

Ultra-fine PM (PM0.5) was collected near the schools involved in the research. High-volume air samplers were located near the schools for 72 hrs during the days of biological sampling. Chemical analysis of PM0.5 extracts was performed for the determination of PAHs and Nitro-PAHs, compounds with genotoxic/mutagenic activity.

Collection of urban air chemical data

Data regarding the main air pollutants for which routine measurements are performed by Regional Agency for Environmental Protection were retrieved for each city.

+ BIG WORDS

Polycyclic aromatic hydrocarbons (PAHs)

constitute a large class of organic compounds whose structural feature is the presence of two or more benzene rings linked together. PAHs are formed during the incomplete combustion of organic material containing carbon, such as coal, wood, petroleum products and wastes. The nitrated polycyclic aromatic hydrocarbons (Nitro-PAHs) are characterized by the presence of one or more nitro groups (NO₂) that replace the hydrogen atoms present in the PAH structures.



Question

How polluted was the air of the five cities?



Answer

Emissions of many air pollutants decreased substantially over the past decades in Italian and European cities thanks to the implementation of environmental policies.

However, there are still notable differences, due to geographical area and climatic conditions, that determine exposure peaks well above the limits prescribed by the current regulations. Air pollutants were confirmed to be associated to the seasons: all levels were higher in winter than in spring, except for ozone, which was more concentrated in the hot season.

+ BIG WORDS

Mutagenicity is the ability of a chemical or physical agent to induce genetic mutations. **Genotoxicity** is a broader term that includes, in addition to mutations, other harmful effects on genetic material. **Environmental mutagenesis** is the research, identification and characterization of chemical and physical agents capable of producing **mutagenic and genotoxic effects** in various plant and animal organisms, including humans.





Air quality assessment



Question

What was the effect of collected PM0.5 on cells exposed in the laboratory?

Was it toxic?

Two different human cell lines (bronchial and alveolar) were treated in laboratory in order to evaluate the effects of PM samples on cell growth and viability.

Did it damage the DNA?

The same cells were used to evaluate DNA damage due to exposure to particulate matter. Two different tests were used: the micronucleus test (MN) and the comet assay.

Did it induce mutations?

Bacterial cells were treated in laboratory in order to evaluate genetic mutation due to exposure to PM samples (Ames test)



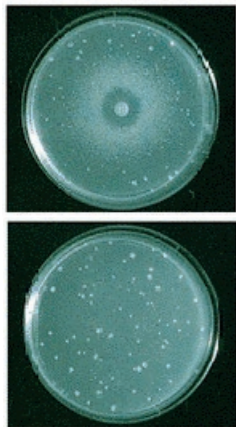
Answer

PM0.5 samples were able to induce toxic and genotoxic damage in cultured cells, even if slight.

The mutagenic properties seemed to be associated with the presence of PAHs and Nitro-PAHs in the samples.

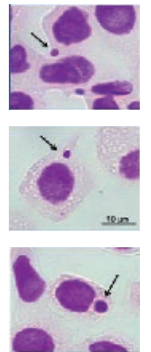
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The Ames test (or reversion test in *Salmonella typhimurium*) is a test used to evaluate the ability of a chemical substance to determine DNA mutations in bacterial cells.



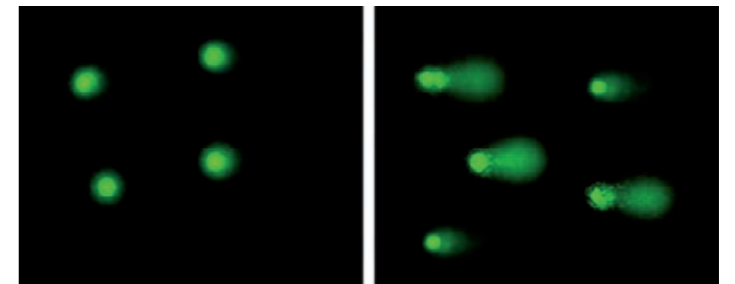
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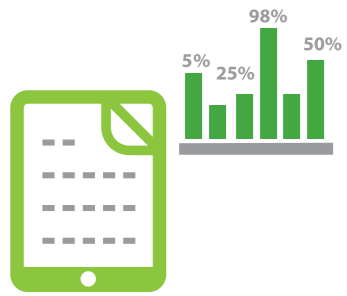
Micronuclei are small accessory nuclei, morphologically identical to the principal nucleus but small in size, detectable in cells with DNA damage



+ BIG WORDS

The comet assay, also known as single cell electrophoresis, is a genotoxicity test for the identification of DNA damage due to the exposure to chemical or physical agents





Questionnaires

A questionnaire on demographic and socio-economic features, presence of disorders and respiratory diseases, indoor exposures, nutrition, physical activity and other lifestyle factors were administered to the children's parents.

Question



What were the features of recruited children?



Answers

The children involved in the MAPEC_LIFE project had the following characteristics:

- They were half male and half female;
- They had parents with high educational level;
- 1 out of 10 children was exposed to passive smoking at home;
- 1 out of 3 children was overweight or obese;
- 1 out of 2 children did not follow the principles of the Mediterranean diet.





Analysis on buccal cells



Question

Were the children's cells damaged?

Toothbrushes were used to collect exfoliated buccal cells by gently scraping the inside of both cheeks. Microscope analysis was performed in order to evaluate the presence of micronuclei in the buccal cells of all the children.



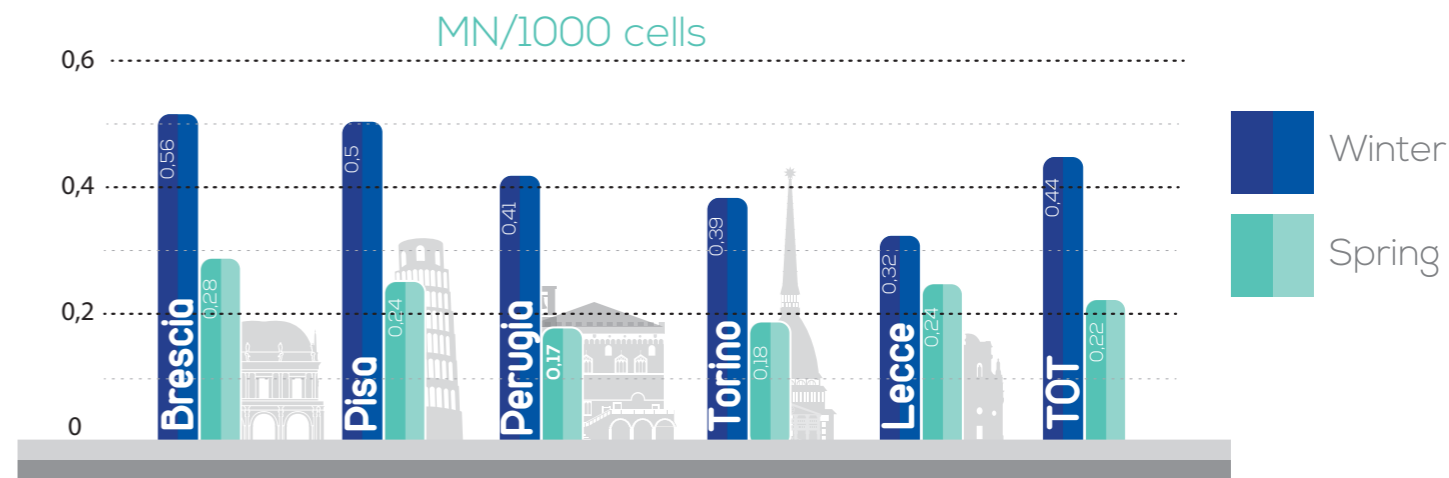
Answers

The biological effects in the buccal mucosa cells of the children was moderate.

In addition, the variability of the effect was very strong, between different children as well as the cells of the same child analyzed in different seasons.

However, a significant difference in the effect was detected in the cells of children living in the 5 cities. The children from Brescia had the highest number of micronuclei, followed by those from Pisa, Perugia, Torino and Lecce.

These differences were also observed in spring, even if the biological effect was halved in this season



Question

Was the presence of micronuclei in the children's cells associated with air quality?



Answers

Among the pollutants investigated, the concentration of benzene, PM_{2.5}, SO₂ and ozone in the air, and of PAHs in PM_{0.5} influenced moderately the number of micronuclei in the children's cells. No significant association was found with the other monitored air pollutants.



Question

Was the presence of micronuclei in the children's cells associated with the children's characteristics and lifestyle factors?



Answers

The analysis of the questionnaires showed that some factors were associated with the presence of micronuclei in the buccal mucosa cells of the children: a healthy diet following the principles of the Mediterranean diet reduce DNA damage, while the exposure to passive smoking and being overweight worsen it.



Education

Our collaboration with the schools created the opportunity to explain to children the main topics of the project: air pollution and its effects on health and on cells, prevention strategies and healthy lifestyles. Didactic tools, such as didactic leaflets for adults, a cartoon and videogames for children were designed. These tools were termed pleasant and effective by a validation study and are available on the project website.



Cartoon



gioco.mapec-life.eu



Videogame

www.mapec-life.eu

An integrated education and communication plan

Brochure



Leaflets

TAKE HOME

MESSAGE

**Air pollution**

In Italian cities, air pollution showed different intensity depending on seasons and geographical areas.

**Particulate matter**

PM0.5 caused mild toxicity and DNA damage in the cells treated in the laboratory.

**Early Biological Effect**

Micronucleus frequency in buccal cells of children was generally low compared to other investigated populations and was influenced by:

- **Season:** the biological effect was higher in winter than in spring;
- **City of residence:** children living in Brescia and Pisa showed a greater effect than those living in Perugia, Torino and Lecce;

- Levels of benzene, PM2.5, SO₂, ozone and PAHs: higher concentrations were associated with higher micronucleus frequency in children's cells;

- **Children's characteristics:** healthy eating reduce the effect while passive smoke exposure and overweight worsen it.

Conclusion

In conclusion, although the investigated children show a modest level of DNA damage in buccal cells, it should be noted that even low levels of biomarkers of early effect may be an indicator of possible adverse health effects in the future.

Project coordinator



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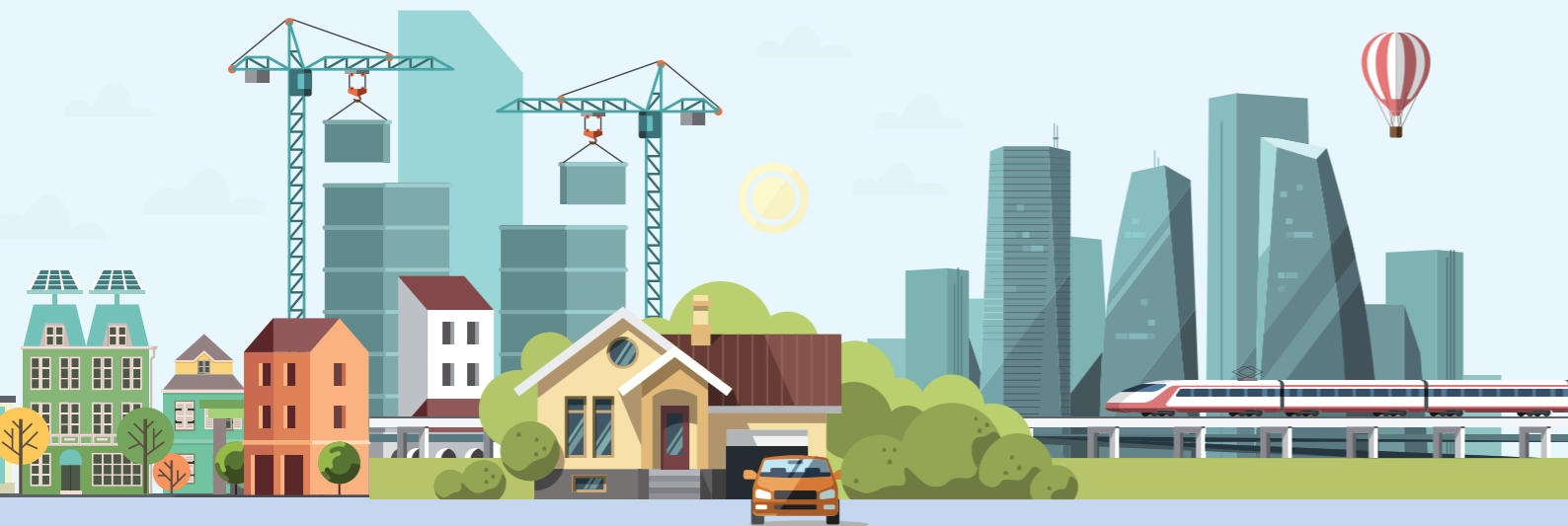
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The research project illustrated in this report was co-financed by the LIFE+ Programme, the EU's funding instrument for the environment and climate action (LIFE12 ENV/IT/000614).





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