



Running For Clean Air Warsaw 2024



Foreword

This summary report of the Running for Clean Air initiative comes a year after World Athletics and the Clean Air Fund first joined forces on this innovative project and agreed to combine respective areas of expertise: running and air quality.

By linking these two fields, Running for Clean Air offers a unique approach to addressing the problem of air pollution. From the air quality perspective, we know that each year, more than 8 million deaths are attributed to air pollution. This is even more than to tobacco which makes the urgency of this issue very clear. Adding the running perspective, we want to consider the sky-rocketing number of recreational runners globally and the mounting evidence of the impact of air pollution on professional athletes as well as regular runners.

This report highlights key aspects of the initiative, including campaign outcomes, air quality data collected, and lessons learned from Warsaw – the first city ever to host the Running for Clean Air initiative.

As the example of the Warsaw running community demonstrates, sport has the power to unite people around important social and environmental issues like air pollution. It shows, too, that communities genuinely care about the quality of the air they breathe and, with support and the right data, they can make a positive difference.

Both our organisations welcome this partnership and we hope that reading about Warsaw will inspire other cities to follow suit.

December 2024

Jane Burston,
CEO and Founder
Clean Air Fund

Stéphane Bermon
Director, Health & Science Department
World Athletics

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“We are fully aware of the responsibility that comes with our leading role in the Polish running market. Clean air is vital for the health of the general population, and by addressing it in our events, we want to motivate global running communities to take action on this matter.”

Marek Tronina, CEO of the Warsaw Marathon Foundation

Introduction

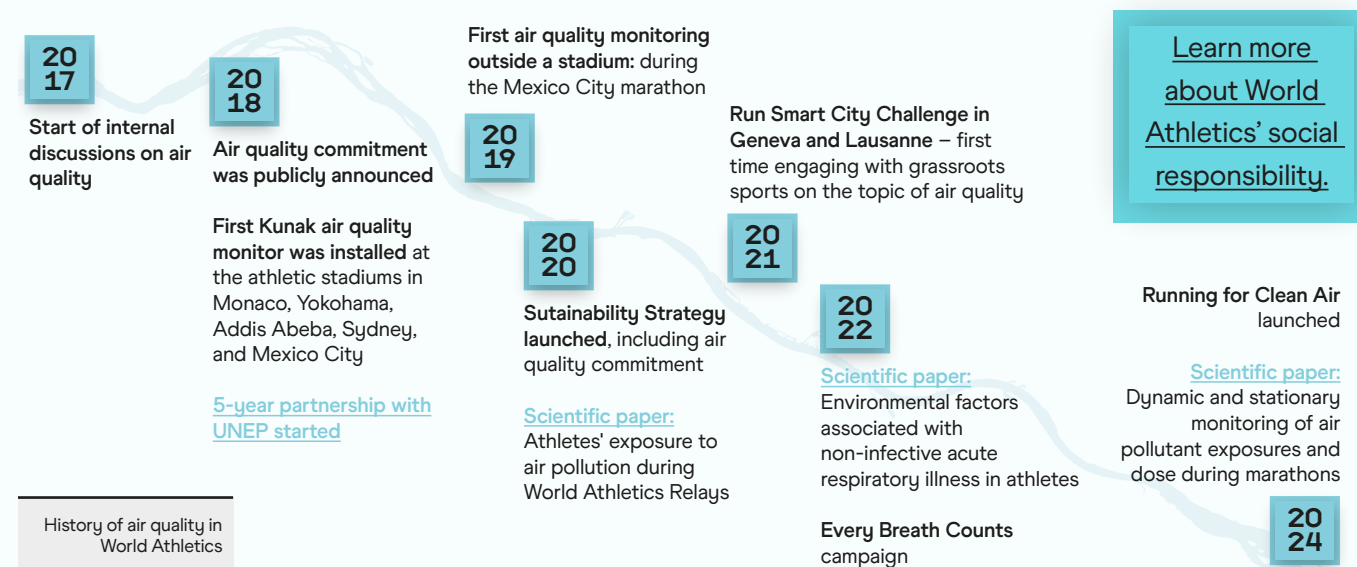
What is Running for Clean Air?

Running for Clean Air is a World Athletics initiative funded by the Clean Air Fund. By integrating air quality monitoring and public awareness campaigns into road running events, the initiative seeks to make clean air a priority for city governments, event organisers, and the public, ultimately contributing to healthier urban environments and better conditions for physical activity.

World Athletics and air quality

World Athletics has been addressing air quality since 2017. Throughout that time, several scientific publications have emerged from the work led by the Health & Science Department. This research provided the foundation for World Athletics' commitment to improving global air quality. Today, air quality is one of the six pillars of the organisation's sustainability strategy and is integrated into its Athletics for a Better World Standard event certification.

The partnership with the Clean Air Fund has allowed this work to expand further by testing the scientific approaches in real-world settings. Running for Clean Air was created to encourage more city residents to be physically active and to highlight the importance of doing so in healthy environments.



“Talking about a challenging and a less known topic, such as clean air, becomes easier when you have already connected over a shared passion for running.”

Dariusz Nożyński, a Polish ultramarathon runner and coach, who led several of the training sessions.

**CLEAN
AIR
FUND**

About the Clean Air Fund

Clean Air Fund is a global philanthropic organisation that works with governments, funders, businesses, and campaigners to create a future where everyone breathes clean air. It funds and partners with organisations across the globe that promote air quality data, build public demand for clean air and drive action. It also seeks to influence and support decision makers to act on air pollution. The partnership with World Athletics is the Clean Air Fund's first collaboration within the sports industry and offers an opportunity to reach new communities and support the delivery of reliable and accessible air pollution data.

Why does air quality matter to running?

One of World Athletics' long-term aspirations is to raise awareness about the health benefits of participating in athletics and regular physical activity. Equally important is creating suitable exercise conditions, where air quality plays a critical role. While science confirms the benefits of exercise, it also cautions us about the risks of breathing polluted air.

Air pollution impacts frequent runners more significantly than those who exercise less often. Regular runners spend more time outdoors, which increases their exposure to poor air quality. They also breathe more heavily, mostly through the mouth, bypassing the nasal filtration mechanisms. As a result, more pollutants enter their bodies, affecting their brain, lungs and heart. Poor air quality not only harms their health but can also reduce athletic performance.

For recreational runners, the health benefits of exercise generally outweigh the risks associated with poor air quality. There is always a positive health impact from exercising regularly, even on days with suboptimal air quality. However, certain measures can help minimise the negative effects of air pollution, as detailed in the Recommendations section towards the end of this report.

Air Quality Measurements

Running for Clean Air aims to equip local communities with the right kind of air quality data.

Thanks to solid datasets, the awareness campaign is evidence-based and offers strong arguments when communicating the health benefits of clean air. This is how the data for this project was collected:

Static monitoring

World Athletics installed a sensor in one of Warsaw city parks and measured air quality and heat stress for six months. Keeping the device in the same location throughout this period allowed for the collection of background information and identification of local pollution trends.



While the sensor can complement existing air quality systems in the city, it also brings a unique perspective. Most existing sensors in Warsaw focus on traffic monitoring or compliance with regulatory standards. In contrast, the device adopted for this project offered a hyperlocal approach. Strategically set at around two meters in height, it precisely reflected the air quality that physically active and exercising individuals were exposed to.

Dynamic monitoring

The Warsaw Marathon was the key event for Running for Clean Air Warsaw. Dynamic monitoring was conducted along the racecourse to capture fluctuations in air quality.

Altogether, Running for Clean Air conducted dynamic monitoring in connection to the Warsaw Marathon 2024 twice. The first dynamic monitoring ride took place on 19 September 2024, ten days before the Warsaw Marathon. The second ride was conducted on the marathon day, on 29 September 2024. The intention behind doing

The monitoring device was installed in Pole Mokotowskie, Warsaw, for six months.

“Making the connection between physical activity and air quality is very important to Polish Athletics. All of us deserve clean air to breathe and the opportunity to live in a healthy environment. This means that we have to think long term and be open-minded about solutions.”

Hubert T Trochimowicz, ESG & Development Consultant from Polish Athletics

What remained the same for the two dynamic monitoring rides	What was different from one monitoring ride to the other
route: both times we followed the Warsaw Marathon racecourse	day: while the first ride was done on a Thursday, the second one took place on a Sunday (weekday vs. weekend)
sensor: the device used was the same: monitoring process hasn't changed	traffic: one ride was with regular traffic while the other took place when the traffic was closed for the marathon

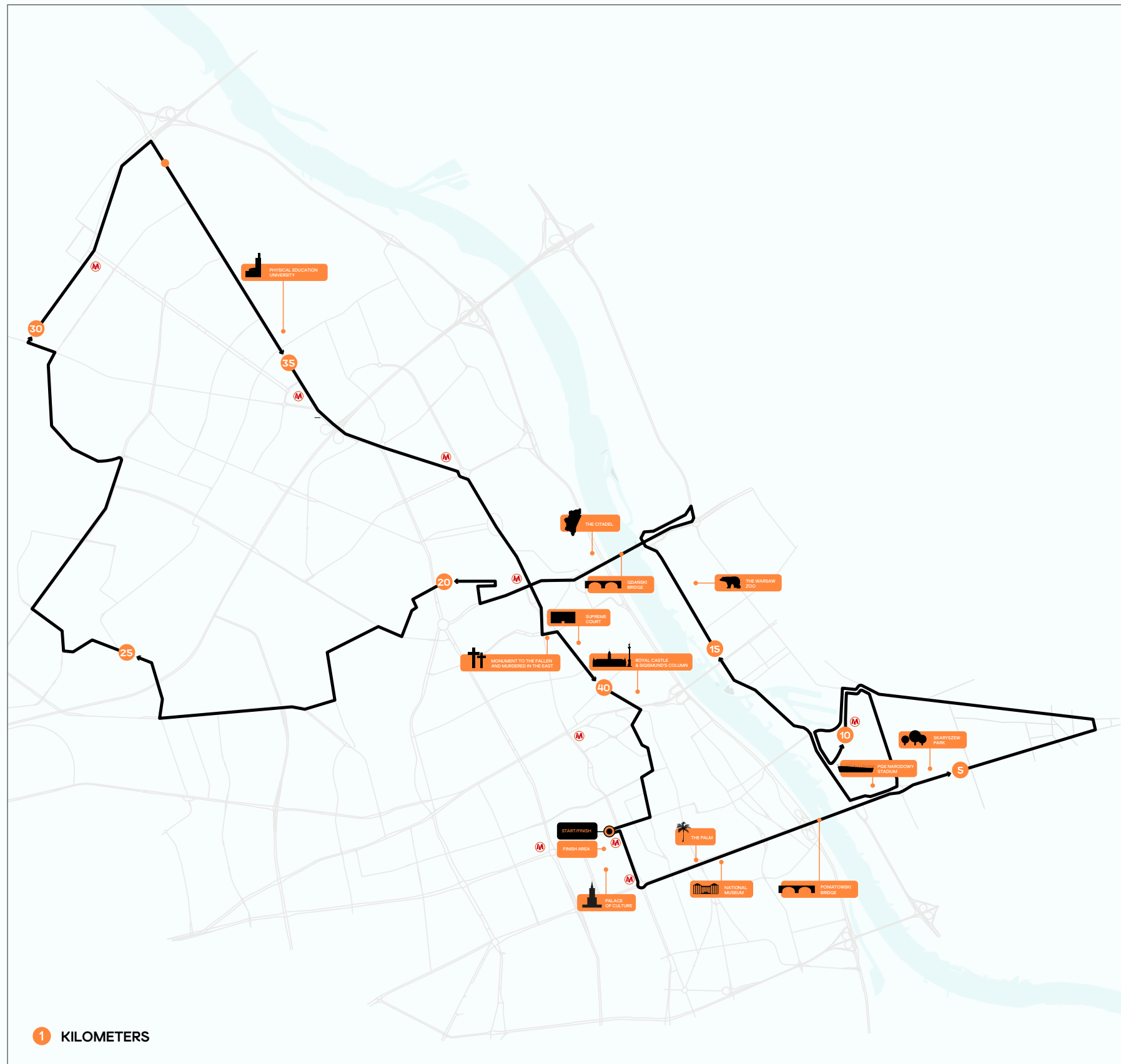
this exercise twice in such a short period was to obtain comparable datasets of the marathon routes: one with usual traffic (on a regular weekday) and one on the marathon day, when the traffic is reduced and road closures are implemented.

The sending frequency was different for the static and the dynamic monitoring. While during the static monitoring, the sensor submitted data every 30 minutes, during the dynamic monitoring, we received data every 5 minutes. With the higher frequency, the marathon course was covered continuously.

The results from both types of monitoring are available later in this report.



A bike with the mounted sensor was used to map air quality during the Warsaw Marathon.



Dynamic monitoring mapped air quality and heat stress along the Warsaw Marathon 2024 route

What was measured?

The sensor used in Warsaw was Kunak Air Pro. This is a commercial sensor system designed for fixed and mobile deployment. It comes at a lower cost than traditional methods while still providing accurate and reliable measurements of key pollutants. It measures air-polluting gases and particulate matters, as well as climate-related data:

- NO, NO₂, CO, CO₂, O₃
- PM2.5, PM10
- temperature, humidity, dew point, wind direction, wet bulb globe temperature

The sensor-systems details and specifications can be downloaded from the [manufacturer's website](#). More methodological details are [published by Ribalta et al., 2024](#).

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SENSING ANYWHERE

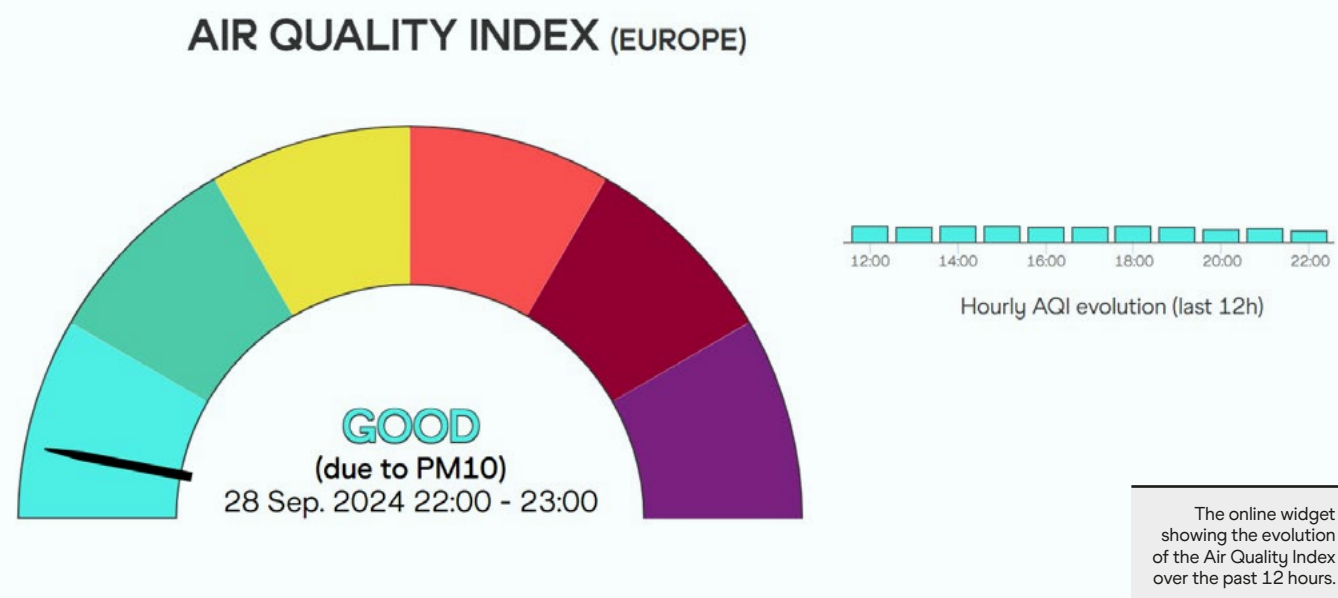


The sensor measured gases, solid particles, and climate-related data.

How Was The Data Shared?

During the six months of static monitoring, an online widget was constantly publicly available, showing the hourly averages of the measured values aggregated into the Air Quality Index and Heat Stress Index.

In addition, the World Athletics team prepared monthly reports with detailed data and analysis, available to local project stakeholders and on the [project's website](#).



“City marathons impact a large part of the city, both in terms of area and population, making them a unique opportunity to raise awareness of air quality issues. It is great to see that our technology can contribute to healthier urban environments in such a unique way.”

Fco. Javier Fernández Huerta, CEO & Co-Founder of Kunak

Warsaw

Warsaw, the capital of Poland, was the first city to host the Running for Clean Air initiative. This year's Warsaw Marathon was the central event in this project and the fact that it also celebrated 100 years of marathons in Poland made it particularly special.

The campaign took place from March to September 2024, when it peaked with the Warsaw Marathon. Months before and after this period were used for planning, networking, and legacy discussions.



At the start zone of the Warsaw Marathon 2024.

Project partners

Running for Clean Air Warsaw was successfully executed thanks to cooperation with the main local project partners:



The activities were supported by the following organisations:

- [Clean Cities Campaign](#)
- [Polish Smog Alarm](#)
- [Warsaw Running Tours](#)
- [Biegowe.pl](#)
- [Rodzice dla klimatu](#)
- [ASICS Poland](#)

Location of the device

The decision on where to install the sensor in Warsaw was made collectively with the main project partners and this process is described more thoroughly further down in the report. The location chosen was centrally placed, easily accessible by public transport, and commonly used by runners – a city park **Pole Mokotowskie**.

It was not the intention to place the device in a location with the best air quality. But to secure the location for the future, so that the local air quality can improve over time and the area can become even more suitable for outdoor physical activity.

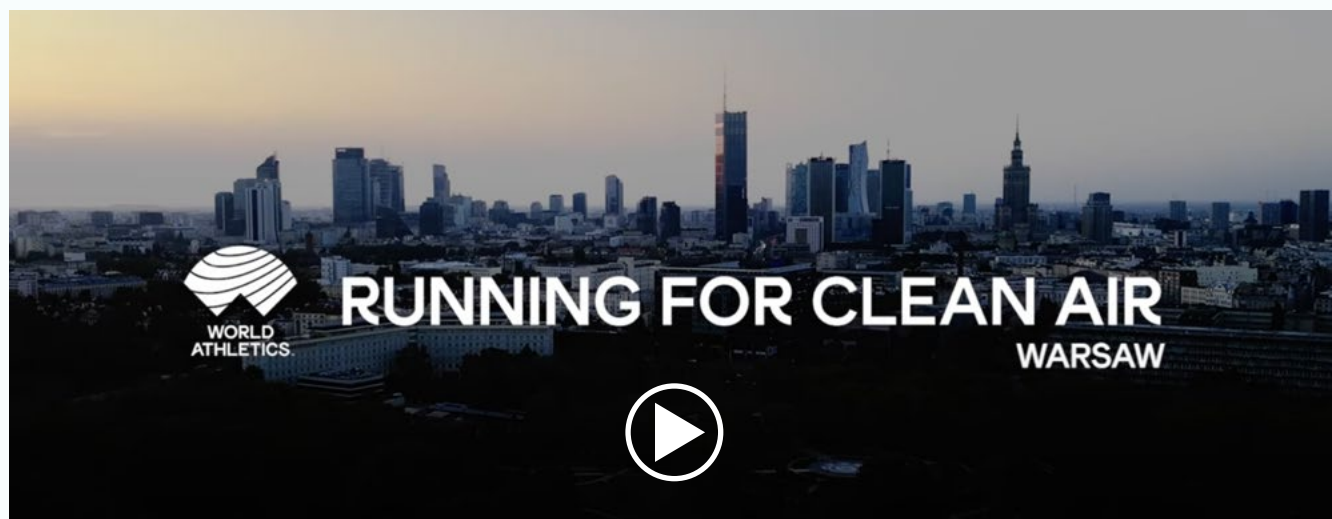
Air quality in Warsaw

Warsaw has a long history of both facing air pollution challenges and taking action to address them.

The city has repeatedly [ranked poorly](#) in air pollution statistics, which left residents exposed to life-threatening pollutants. Numerous actions by the local government, including the replacement of substandard heating systems in households, have led to significant improvements in Warsaw's air quality. The city has addressed emissions from the residential and communal sectors, successfully reducing levels of harmful benzo[a]pyrene. However, transport emissions remain a significant issue, highlighting the need for further urgent action. This made the introduction of **Warsaw's first low-emission zone**, which came into effect during the Running for Clean Air campaign in the summer of 2024, a particularly significant step. One year prior, in 2023, a global initiative Breathe Cities was launched, and Warsaw was part of it from the beginning. The city's ambition is to cut its emissions in half by 2030 by reducing PM_{2.5} and NO₂ – currently the two most prevalent pollutants.

This strong commitment to cleaner air was a key factor in choosing Warsaw as the host for the pilot edition of Running for Clean Air. The city's efforts clearly demonstrate that air quality is a top priority for local authorities and residents alike.

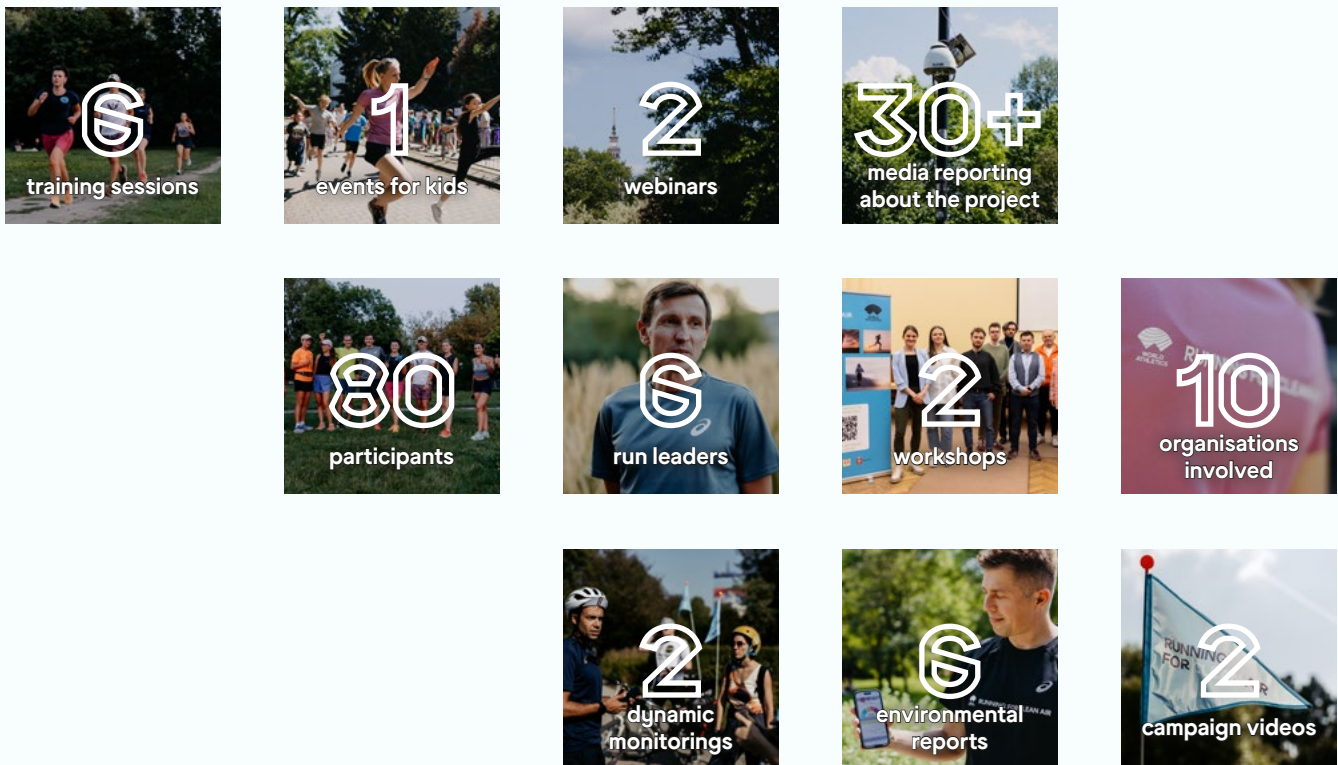
Promotional video:
Why do you care about
clean air?



Project Outcomes

Awareness campaign

The six months of air quality measurements were accompanied by local air pollution awareness campaign. This consisted of the following efforts and events:



[Read an article about the project launch.](#)

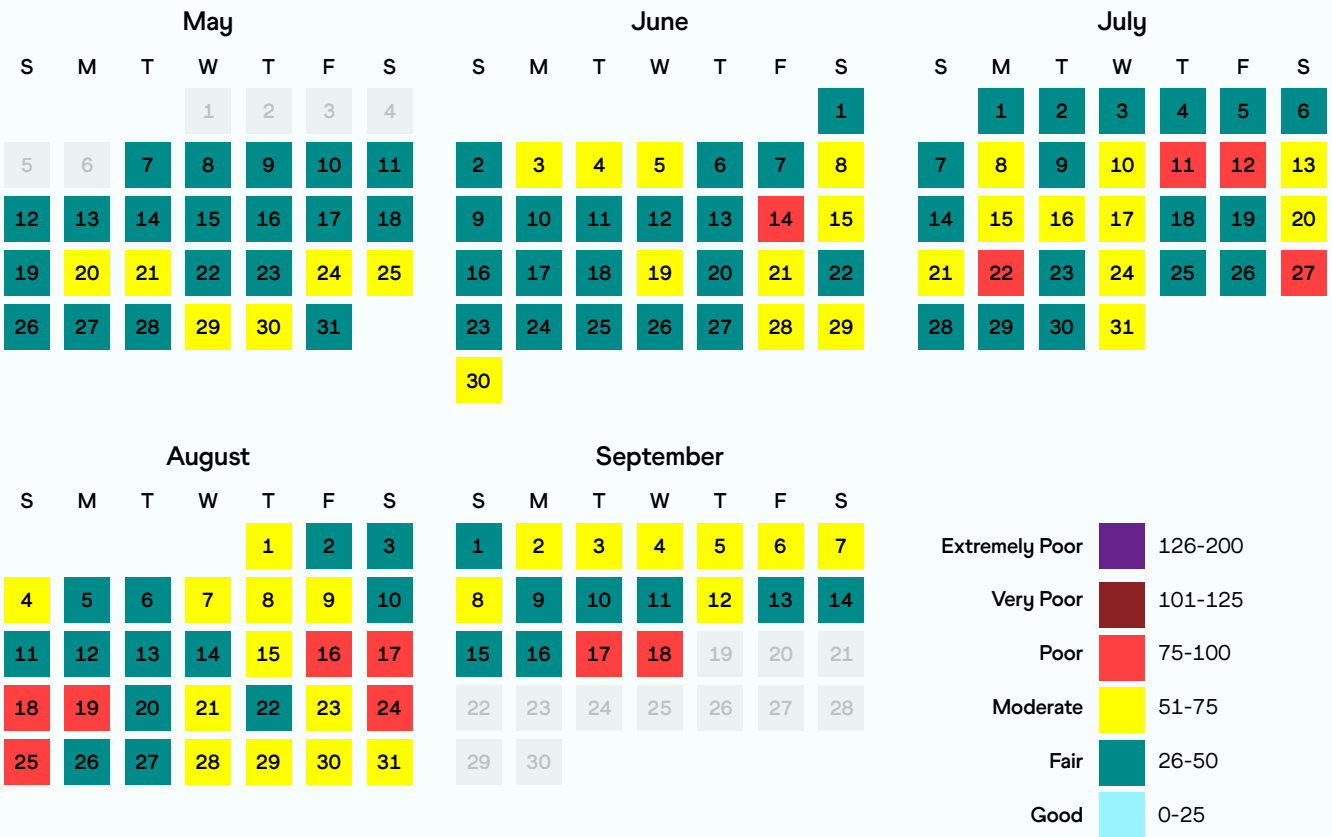
“As a sports company, joining World Athletics to promote physical activity in our city was a very natural thing to do. The project is solid proof that sustainability is an essential part of the sports industry.”

Daniel Bogacki, Activation Specialist in ASICS Poland

Measured data

Static monitoring: air quality

We used the European Air Quality Index (AQI) to aggregate the individual measured values of O₃, NO₂, NO, PM10 and PM2.5. The index varies from “good” to “extremely poor”, based on the poorest level of any of the five pollutants.



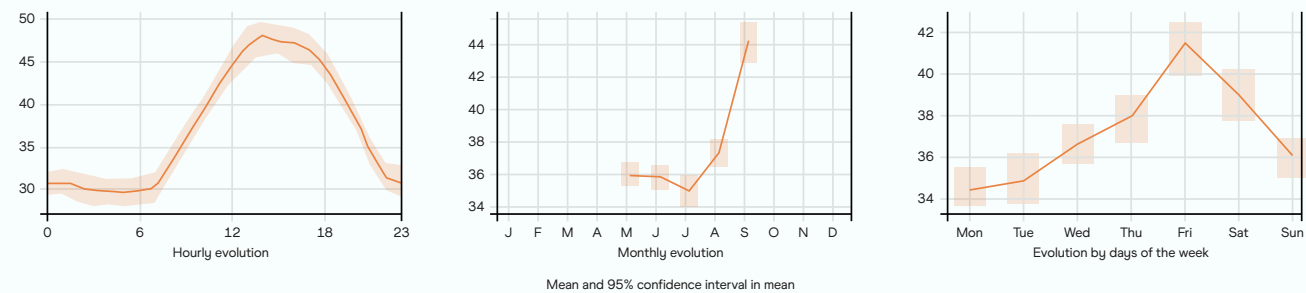
AQI calendar plot from Pole Mokotowskie over the project period

This first graph shows the evolution of AQI over time using a calendar to represent the value of a statistical parameter in colour scale, based on a daily aggregation.

The first weeks of the project showed relatively low levels of AQI, staying mostly within the fair level. It was on 14 June when we first recorded a day with poor air quality (AQI = 76). The situation further declined in July and August, but even in these months, poor remained the worst result recorded, the highest score being 80 on 16 July. September brought improvement, with a reduced number of just two poor air quality days.

It is common to observe worsening of AQI with the arrival of summer and this worsening is most likely caused by ozone. Ozone is created in the presence of sunlight so, there is a direct association of high ozone levels with elevated temperatures.

After September 18, the sensor was moved away from Pole Mokotowskie and used for the dynamic monitoring.

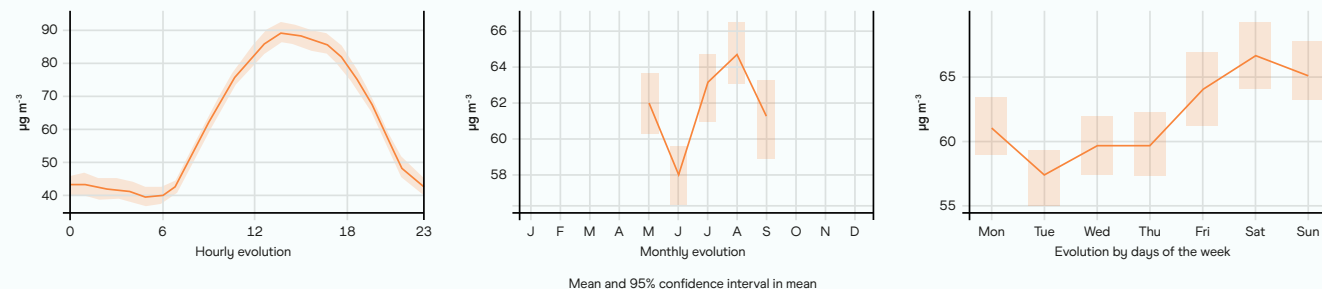


We are also able to break down the data by day and time. These time variation graphics allow us to analyze the variation of a statistical parameter of a sensor concerning different cyclic periods (hours, days, years, etc.), thus, establishing patterns of evolution in the behavior of the parameter that is being analyzed.

Just looking at these graphs, it is easy to spot that the most polluted day of the week was Friday and the most polluted time of the day was between 14 and 16 o'clock. This gives us already a good indication of what the most suitable times for physical activity at this location are.

Breakdown of individual pollutants

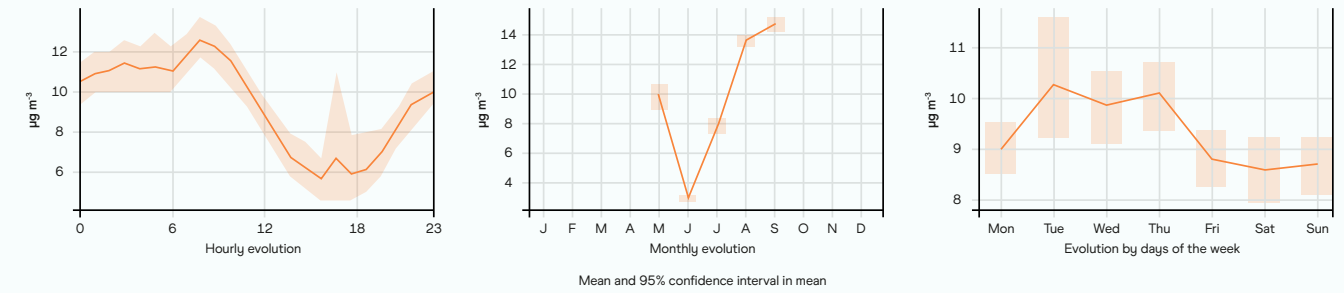
The poor air quality levels in Pole Mokotowskie were mainly caused by ozone (O_3) and PM2.5.



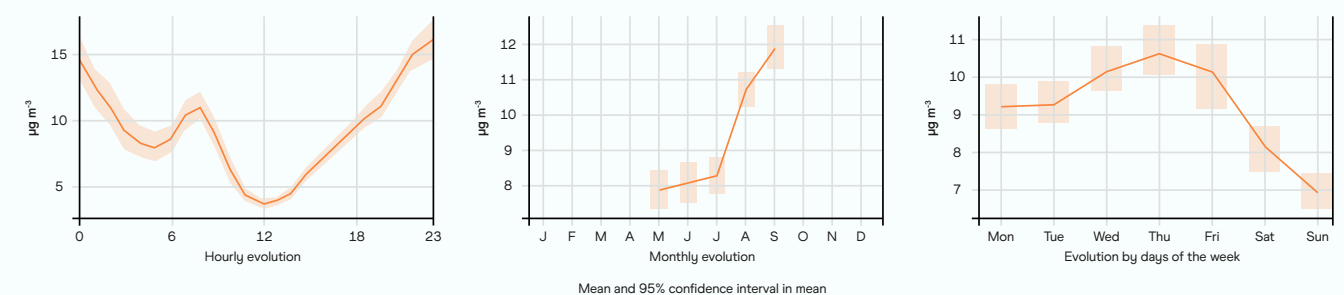
There were already relatively high levels of ozone in May, and this increased over the summer as the temperature continued to rise. We regularly saw the “mid-afternoon peak” of ozone, which typically goes down after the fumes from the morning rush hour have time to react with the sunlight.

“The local aspect of Running for Clean Air allows everyone to participate. It made me realise that even I have a role to play in the fight for clean air and gave me the voice and tools to do so.”

Michał Dzida, Founder of Warsaw Running Tours

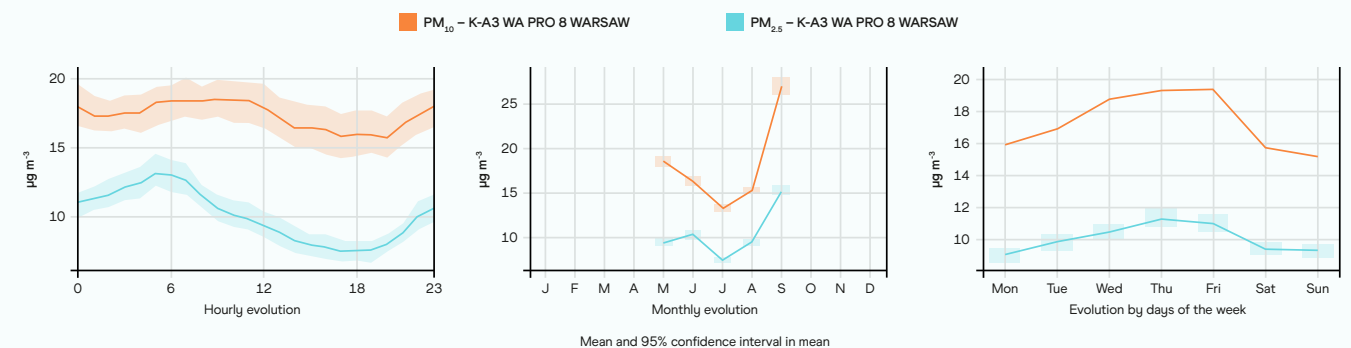


NO levels over the project period



NO₂ levels over the project period

Gaseous pollutants (NO₂ and NO) demonstrated relatively low values throughout the whole period and, therefore, did not represent a significant risk to health.

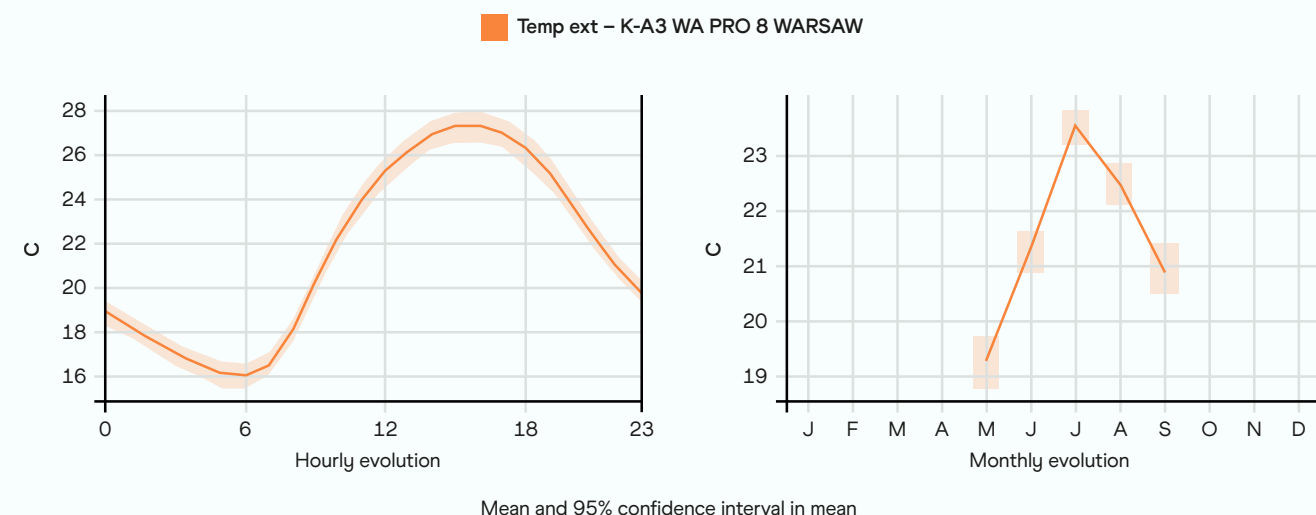


Particulate matter levels over the project period

On the contrary, PM2.5 and PM10 showed higher concentrations, especially in the mornings. In the situation of Pole Mokotowskie, it cannot be determined whether these compounds were coming from natural sources (vegetation) or anthropogenic sources (industry, road traffic) and likely it was a combination of both.

Static monitoring: heat stress

Alongside air quality, we have also been monitoring wet bulb globe temperature (WBGT), which is a comprehensive measure of heat stress consisting of data for air temperature, wind speed, humidity, and solar radiation. The higher the WBGT, the higher the risk of heat-related health issues for people exercising in the area.



In May, WBGT remained low but in June, the index started to indicate significant heat stress. As expected, July and August were the hottest months and in September, WBGT started to decrease again.

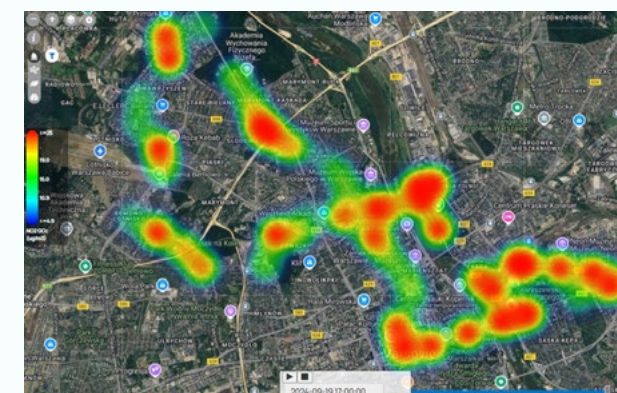
Seeing these patterns gives us a good understanding of what the most suitable times for exercising are in this area. With this knowledge, runners can minimize the negative impacts of heat stress on their bodies. Concrete recommendations are provided on page 20.

Dynamic monitoring

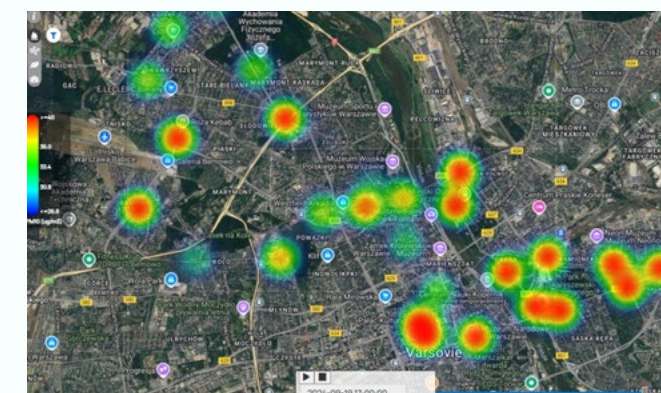
The data collected during the dynamic monitoring enabled effective visual analysis of the marathon course. Unfortunately, due to a major technical issue, the data from the second monitoring ride (the one on 29 September) was not submitted to the cloud and despite long and intense efforts, we have not managed to retrieve access. Therefore, the following results are solely from the first monitoring ride (on 19 September) and a comparison of the two rides is not possible.

Heatmaps were plotted to identify pollution hotspots linked to the design of the race-course (e.g., street canyons, vicinity of major roads, etc.). The following two heatmaps show the intensity of values of PM10 and NO₂. The reason to create heatmaps with these two pollutants is because they are typical of situations we may encounter in urban environments. Particulate matter is primarily emitted by combustion sources, such as vehicles, diesel engines, and industrial facilities. It can also be generated from construction sites, unpaved roads, fires, smokestacks, and wood stoves, or agricultural operations. Short-term exposures to PM10 have been associated primarily with worsening of respiratory diseases, including asthma and chronic obstructive pulmonary diseases. NO₂ is a traffic-related air pollutant and its association with cardiovascular and respiratory mortality following short-term exposure.

Temperature over the project period



Heatmap of NO₂ along the marathon course on 19 September 2024.



Heatmap of PM10 along the marathon course on 19 September 2024.

It is visible that while the intensity of the two was different along the course, their hotspots (the red areas in the pictures above) were similarly located. Studying the urban plan of those areas, the most straightforward explanation is that these hotspots are caused by major intersections.

Data summarised

Thanks to the long-term monitoring of air quality and heat stress in one unchanged location, we are able to draw conclusions about local trends and air pollution patterns and provide recommendations to the local community.

“Engaging with the running community over air quality gave us a completely new perspective on the issue and it nicely connected the dots as both physical activity and clean air are important factors for people’s health.”

Marcin Grądzki, Director of the Air Protection & Climate Policy Department in the City of Warsaw

Key findings

- 1. Aggregated Air Quality Index data suggests that September is the month with the worst air quality. However, August is the month with the most days with poor levels of AQI.
- 2. The day least suitable for physical activity in Pole Mokotowskie is Friday, according to AQI.
- 3. Ozone levels reached their peak in the early/mid-afternoon, after exhaust fumes from morning rush hours have had time to react to the sunlight. August was the month with the worst ozone values.
- 4. Aggregated data of the hourly evolution for NO₂ and NO do not show any typical trends which suggests only a moderate influence of vehicle traffic emissions (morning and evening rush hours) in this location.
- 5. PM2.5 and PM10 showed higher concentrations in the mornings.
- 6. WBGT index in June represents a significant level of heat stress for training athletes (4 days in 28- 30°C and 9 days in 25-28°C).

Recommendations

We recommend that the local communities continue to monitor air quality regularly. The most effective way to protect oneself from air pollution is by limiting exposure, which is only possible when people have easy access to information about the current air quality. With this information readily available, runners and other individuals exercising outdoors can take the following precautions:

- 1. Adapt the times of your exercise:
 - a. avoid exercising during rush hour – early mornings, noon times, or evenings offer generally better air quality
 - b. avoid exercising during ozone peak times (usually in early afternoons)
 - c. if the air quality is particularly bad, consider exercising for a shorter time
- 2. Adapt your running route:
 - a. avoid major roads, construction sites, and densely built environments
 - b. go to parks, run on open streets

Success Story From Warsaw

Deciding on a monitoring location

Running for Clean Air is like a recipe – a set of ingredients that we offer to each city, enabling them to cook their own unique dish. The project is designed to fit the specific needs of any city and maximise its local potential.

In Warsaw, before the project could officially launch, the main partners had to decide where to install the air quality sensor, which would stay in place for six months. Talking of maximising the local potential, it was important to find a suitable space for the project’s needs. Internally, this space was referred to as the “Urban Clean Air Training Area”: a space that was already popular with exercisers, easily accessible by public transport, and well-frequented by city residents.

Each partner proposed several locations, resulting in an initial list of eight potential sites (see the table below). To assess the popularity of these locations among runners, the World Athletics team used StravaMetro, a platform that provides aggregated data on running, walking, and cycling for commuting or leisure. This data revealed which locations were most frequented by Strava users and provided insights into the busiest months, days, and times for these areas (information that later proved invaluable in determining the optimal timing for training sessions).

Based on the StravaMetro data, the team narrowed down the options to a top three, making the final decision a smooth consensus. Pole Mokotowskie emerged as the best choice—not only because it was feasible (permit-wise), but also due to its central location.

This collaborative and data-driven approach strengthened the initiative in Warsaw and validated that the Running for Clean Air “recipe” could be adapted and successfully implemented in cities around the world.

Las Kabacki
Pole Mokotowskie
Lasek na Kole
Agrykola
Kepa Potocka
Bulwary Wislane
Las Sowieckiego
Park Skaryszewski

A long list of all suggested locations for the Warsaw’s Urban Clean Air Training Area

Next Steps

Warsaw was the first city to test Running for Clean Air, but it will not be the last. Around the time of this report's publication, the initiative is already well under way at one other location: Lagos, Nigeria. Reflecting on the universal recipe mentioned in the previous chapter, you can be sure that the initiative has a very different “flavour” [in Lagos](#) than it did in Warsaw.

The insights gained from these two locations are pivotal for our team as we would like to continue our efforts and expand into additional locations in future. Updates on the next steps will be available on the [World Athletics website](#).

“We supported Running for Clean Air because we have common goals. We care about urban environments enabling its residents to live in a healthy and active way.”

Nina Józefina Bąk, Head of Clean Cities Campaign in Poland





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