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The risk of hidden "hot spots" with high levels of air pollution in Madrid (Spain)

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ABSTRACT

All urban areas at risk of breathing polluted air should be identified. In the outskirts of Madrid (Spain), there are roads with high traffic (highway A5) that are <5 meters away from nearby residential homes and schools with children and adolescents. The objective of this study is to ascertain the levels of NO_2 in these populated areas. Several NO_2 diffusion tubes were installed at a height of 3-m to measure NO_2 concentrations in various locations of the A5 during the month of May 2022 (30 days). The four tubes located near the A5 measured a NO_2 concentration of 49.7; 88.2; 56.8; and 60 μg/m³. The standard deviation and variation coefficient of the measurements were 0.5 and 2.7%, respectively. According to the WHO (2021), the admissible average annual limit is 10 μg/m³ and the daily limit is 25 μg/m³. This study aimed at measuring the concentration of NO_2 near homes and primary and secondary schools located in a "toxic microenvironment" (close to the A5 in Madrid) found high and dangerous levels of NO_2 impacting the health of the population. This is an area with a population of low socioeconomic level, which increases the impact on health.

Keywords: Environmental health; Health equity; Social determinants; Transport; Urban Health

INTRODUCTION

The correlation between air pollution and its impact on health has been duly demonstrated (1-6).

In compliance with current regulations, official stations to measure gases and particles of air pollution (Automated Measurement Systems [AMSs]) are installed in the central core of cities or in concentric circles. However, AMSs do not reach the most remote residential areas, which, however, have high volume traffic routes.

There are 24 AMSs in the city of Madrid. These so-called "traffic" AMSs are in central areas of the city, where the level of pollution is affected by high volume vehicle traffic emissions.

Some of the residential homes and schools are located <5 m away from the eight lanes at the start of highway 5 (A5) in Madrid (Spain) (Figure 1). According to official data (7), an average of 100,000 vehicles circulated daily on the A5.

The AMSs closest to the A5 are about 1.5 km away and the data yield is not useful to determine the concentration of gases and toxic particles inhaled by the population living closest to the polluting site.

It is therefore imperative to be able measure air quality in those areas given the potential impact on the health of its residents, children, and students, whose homes and schools are right next to the A5 (1-6). Moreover, most of this population is at increased vulnerability due to their socioeconomic level. A paper referring to this circumstance (1) was recently published, in which government regulations on air pollution control systems may have failed to include.

METHODS

In May 2022, four NO_2 diffusion tubes (8) were installed at a height of 3 m to measure and collect data on NO_2 concentrations in various locations near the A5: 4.5 km, 5.2 km, 6.3 km, and 7.8 km. The preparation of the tubes and their analysis was carried out at the Chemical Laboratory II of the Higher School of Industrial Engineering of the Polytechnic University of Madrid. Other four tubes were installed in a municipal AMS station for tube calibration. The temperature was taken from a nearby AMS and was used only to correct the NO_2 diffusion coefficient and to calculate its concentration.

These tubes are made of methacrylate with a grid impregnated with an aqueous solution of triethanolamine that absorbs the NO_2 present in the atmosphere. The amount (mass) of NO_2 captured by each tube is determined by visible spectrophotometry and the amount in the atmosphere is calculated using the NO_2 diffusion coefficient in the air that is mainly temperature dependent.

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FIGURE 1. Highway A5 Madrid (Spain). km 5.2 School next to the Highway.

RESULTS

The monthly average of NO_2 (μg/m³) in May 2022 in the two municipal AMSs (1.5 km from the A5) located closest to our study area was 10 and 21 μg/m³, respectively.

In that same period (30 days), the four tubes located along the A5 measured a NO_2 concentration of 49.7; 88.2; 56.8; and 60 μg/m³. The standard deviation and variation coefficient of the measurements were 0.5 and 2.7%, respectively.

DISCUSSION

According to the WHO (2021), the admissible average annual ambient air pollution value is 10 μg/m³ and the daily limit value is 25 μg/m³ (1).

Our NO_2 measurements were taken over the course of 1 month (May). It is a known fact that at this time of the year, there is a lower concentration of polluting gases and particles in Madrid. It is, hence, assumed that the potential repetition of this study in the autumn-winter months may magnify these differences. In this period, there were no high levels of COVID infection in Madrid**.**

Socioeconomic determinants contribute to the effects of polluting gases and particles on health. As stated by Hoffmann et al.: "To maximize health benefits, we now understand better the importance of implementing measures to reduce average exposures of all people. Such an approach must complement reductions in exposure at "hotspots" with high levels of air pollution, in particular to address known inequities due to socioeconomic conditions, increased vulnerability of the residential population (1)."

Because the tubes provided an average value of the NO_2 concentration during the exposure period, the measurement is representative of what happened during those 30 days, taking into changes in emissions, rain, wind (9), and thermal inversions (9,10).

Our study was carried out in May with no heat wave recorded in that period (6).

Other procedures (11,12) have been used with the same objectives.

As limitations to this study, it should be noted that it was not possible to measure the concentrations of PM10 and PM2.5 particles, which are 4 times more lethal than NO_2 (12,13).

CONCLUSION

This study on the concentration of NO_2 near homes and primary and secondary schools located in a "toxic microenvironment" (close to the A5 in Madrid) found high and dangerous levels of NO_2 in the population, which is obliviously exposed to these pollutants, despite compliance with the general official standards for monitoring air quality in Madrid currently in force.

Comprehensive public health policies should include tools for the detection of areas that are more likely to be toxic to the population living in the periphery, especially if there are schools in such areas, as well as an improved decision-making process to mitigate the impact of air quality on health should also be part of such policies (14,15).

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