How Does Outdoor Air Quality Vary for Schools in Glasgow?

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Introduction

Using data from the Scottish Government summary statistics for schools (2022) and recorded outdoor air pollution levels for NOx and PM2.5 (DEFRA, 2022), this report investigates how outdoor air quality varies for schools in Glasgow, focusing on the disparities experienced by different socio-economic groups.

The primary objective is to understand how socio-economic factors, such as deprivation levels, special needs status, and ethnic makeup, influence the air quality experienced by students. The analysis aims to reveal whether these socio-economic factors correlate with poorer air quality, thereby highlighting potential inequalities.

By shedding light on these disparities, this report seeks to contribute to ongoing discussions about environmental injustice and the importance of ensuring clean air for all students, regardless of their socio-economic background.

Children are particularly vulnerable to the adverse effects of air pollution as their lungs, brains and other organs are still developing. Children also breathe more rapidly, taking in a greater amount of air relative to their body weight. Furthermore, children are closer to the ground where pollutant concentrations are higher (World Health Organisation, 2018; European Environment Agency, 2023).

Currently, there are no specific policies in place for air pollution control in Glasgow schools. However, Glasgow City Council's (2024) Air Quality Action Plan for 2024-2029 prioritises a comprehensive review of air quality monitoring in Glasgow, with a focus on schools, hospitals, and care homes—areas with more vulnerable populations, susceptible to air pollution.

Research, such as this report, looks to identify air pollution disparities and hotspots within the Glasgow school community, bringing attention to policymakers the need for addressing areas of environmental inequality.

Background

Defining air pollution

While all forms of air pollution have adverse health impacts for children, the two air pollutants of discussion in this report are Nitrogen Oxides (NOx) and Coarse/Fine Particulate Matter (PM10/2.5) (see Table 1).[1]

Nitrogen oxides, an umbrella term for referring to nitric oxide (NO) and nitrogen dioxide (NO2) together, is a form of gas pollution, mainly produced during the combustion of fossil fuels. NOx exposure leads to inflammation of airways and is therefore extremely harmful to those with existing lung and heart conditions. NOx can also increase likelihood of experiencing short-term respiratory conditions and other negative long-term health outcomes (see Table 2) (GOV.UK, 2022).

Particulate matter refers to the non-gaseous matter in the air. Particulates are classified by size, with a current focus being on particles with a diameter below 10 micrometres (µm) and below 2.5 micrometres (µm) – PM10 and PM2.5.

Given the small size of PM particles, there is risk of the toxins entering the bloodstream and transporting around the body, embedding into the heart, brain, lungs or other vital organs. Exposure to PM can result in serious negative health outcomes (see Table 2) and is particularly harmful to vulnerable groups of people such as children, the elderly, and those with existing health conditions (DEFRA, 2021; UNICEF UK, 2018).

Table 1: discussed outdoor air pollutants and their main source

Pollutant	*Abbreviation*	*Main Source of Pollutant (Outdoor)*
Nitrogen Oxides	NOx	Vehicle emissions
Coarse particulate matter (<10µm in diameter)	PM10	Most PM concentrations come from inorganic matter from human activity, such as black smoke, vehicle emissions, and vehicle wear.
Fine particulate matter (<2.5µm in diameter)	PM2.5	Concentrations also include biologic agents (such as pollen) and inorganic matter unrelated to human activity (such as ocean spray)

(Catalano, 2024)

[1] For a more in-depth discussion on the link between air pollution and health, see 'What do we know about the relationship between air pollution, health, and inequality in Glasgow?' by Allison Catalano (2024).

Table 2: discussed outdoor air pollutants and their observed health outcomes for children

Outdoor Pollutant	*Health Impact on Children*
PM10/2.5	Adverse birth outcomes and infant mortality; negative neurodevelopment – lower cognitive ability, increase in behavioural disorders; respiratory conditions – asthma, pneumonia, bronchiolitis; childhood cancer; childhood obesity.
NOx	

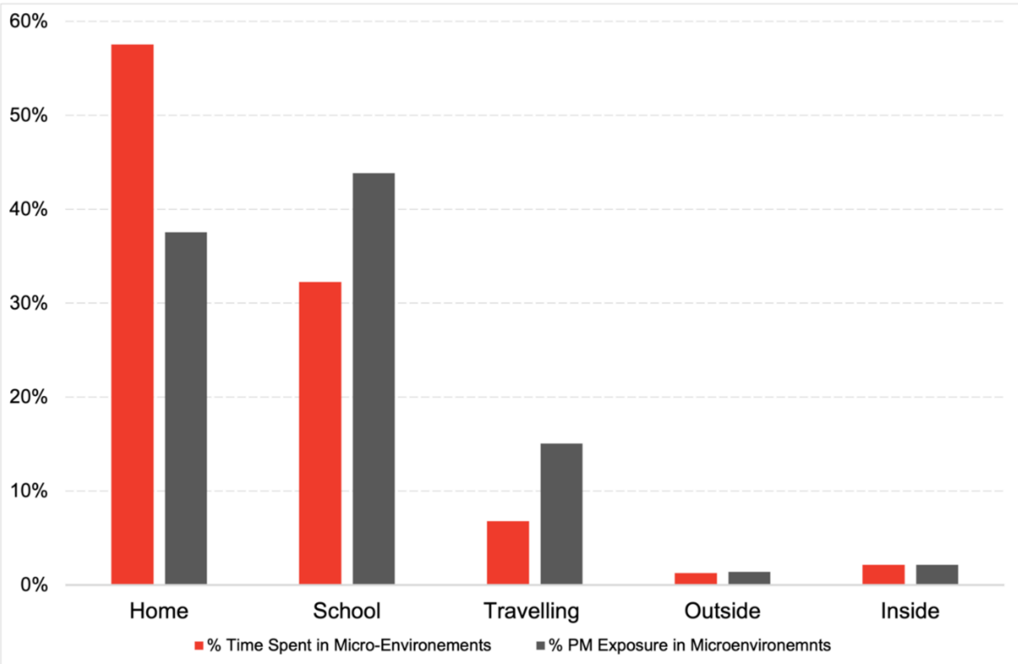
(World Health Organisation, 2018; Catalano, 2024)

School Air Pollution Exposure

Children face multiple exposure points to air pollution throughout their school day. Significant peaks in outdoor air pollution have been observed in playgrounds, during lunch breaks, during the school commute and at the school gates (UNICEF UK, 2018; Osbourne et al, 2021a).

While children spend only 30% of their time at school, 44% of their daily black carbon exposure is experienced here. What's more, traveling to and from school accounts for just 7% of the day but contributes to 15% of their daily black carbon exposure. Hence, an average 59% of children's daily black carbon pollution intake occurs during the school day. This is in contrast to home where children spend about 60% of their time, but where only 38% of their daily black carbon PM exposure is experienced (UNICEF, 2018). This disproportionate relationship (see Figure 1) underscores the importance of monitoring air pollution levels in schools.

Figure 1: Average Time Spent in Microenvironments vs Average Black Carbon Exposure



(UNICEF, 2018)

Several factors further exacerbate pollution exposure around schools, such as traffic volume and proximity to busy roads. This is especially true at school gates, which, due to vehicle drop-offs and idling engines, are pollution hotspots. Urban design also plays a role, with denser building areas and limited green space contributing to higher pollution levels. Seasonal variations also affect pollution, with higher observed levels in colder months due to increased central heating use and a preference for cars over walking or public transport. Additionally, the route and mode of transport during commutes impact exposure levels, with routes through busy roads contributing more to pollution than routes through parks, and cars or buses being more polluting than cycling or walking (Osbourne et al., 2021a; Impact on Urban Health, 2020).

Air Pollution and Ethnic Minority Students in Glasgow Schools

For the 2022 Glasgow City data, a positive correlation has been found between the percentage of ethnic minority students in a school and the level of air pollution.

Figure 2 displays background concentrations of NOx and PM10 pollutants for Glasgow, mapped on a 1km x 1km grid, with darker squares indicating higher concentrations and lighter squares indicating lower concentrations.[2]

Figure 2 illustrates this positive relationship, where darker polluted areas are more heavily populated by darker purple dots (schools with a higher percentage of ethnic minority students).

An analysis comparing air pollution levels between schools with the highest and lowest percentages of ethnic minority students shows the following:

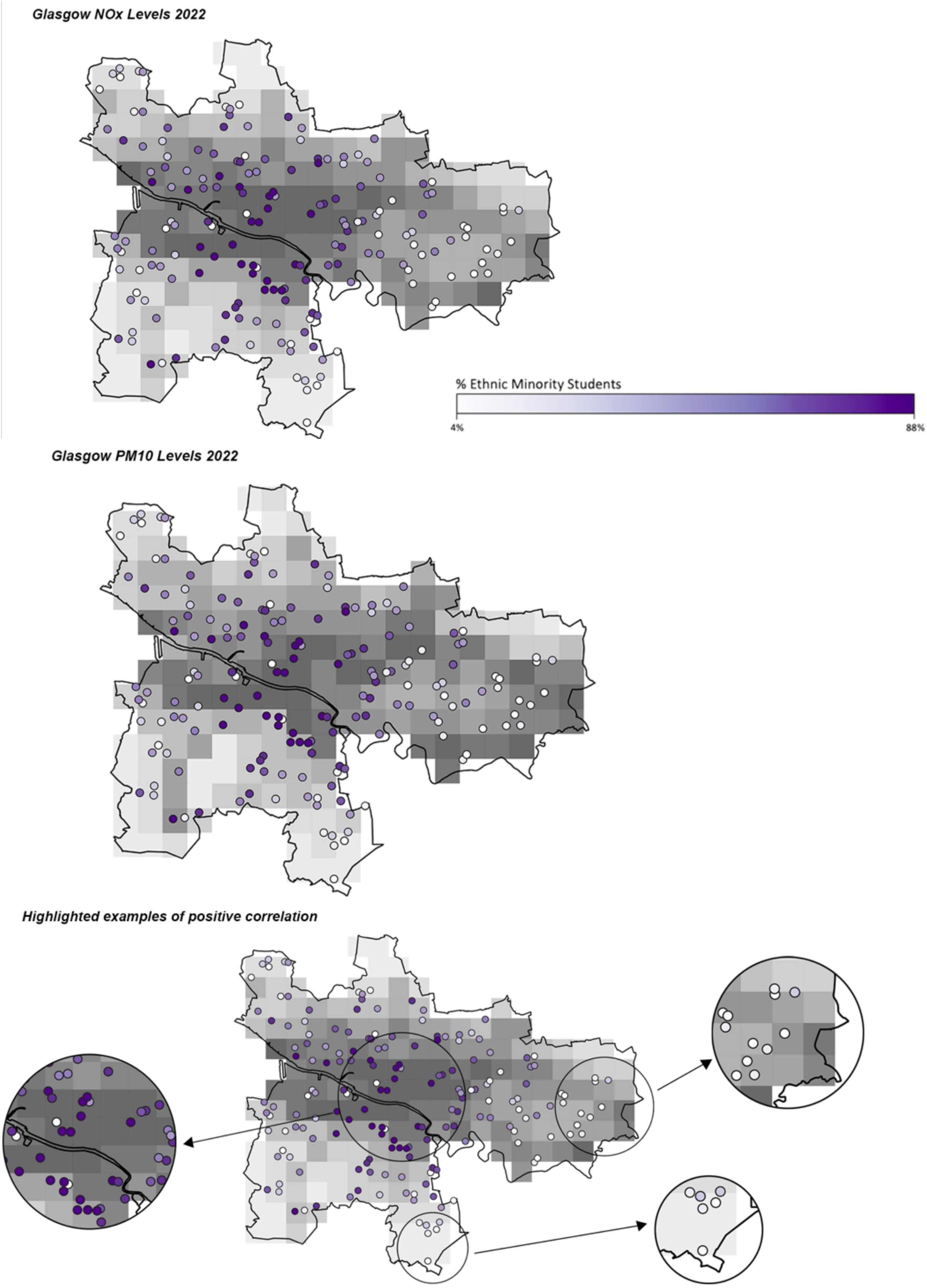
Table 3: comparison analysis of ethnic minority students and pollution levels

Schools with…	*Average NOx µg/m^3*	*Average PM2.5 µg/m^3*
16% or less ethnic minority students	14.68	5.14
35% or more ethnic minority students	19.01	5.38
Difference of average pollutant levels	4.33	0.25
% Difference of average pollutant levels	22.79% higher	4.59% higher

This analysis shows that in 2022, schools with a higher percentage of ethnic minority students experienced ***higher*** average levels of NOx and PM2.5 emissions compared to schools with a lower percentage of ethnic minority students.

[2] It is important to note that while PM10 levels are modelled in the diagrams, PM2.5 is discussed in the text. This discrepancy is due to the Scottish Air Quality Data (SAQD) being able to only provide background concentrations for PM10 but not PM2.5. However, since PM2.5 particles are included within PM10 measurements, the data remains relevant.

Figure 2: Percentage of Ethnic Minority Students Per School Mapped Against Air Pollution Levels



(Scottish Government, 2021; 2022)

Air Pollution and Deprivation Level in Glasgow Schools

In contrast to our previous findings, a negative correlation was found between the percentage of students being of the lowest SIMD quintile (Quintile 1) and the level of air pollution.

Figure 3, similarly to the previous diagram, illustrates NOx and PM10 pollution levels by greyscale squares and Glasgow schools by dots – this time coloured on a red scale, with darker red dots being schools with a higher percentage of SIMD Quintile 1 students and paler red/white dots being schools with a lower percentage.

Figure 3 illustrates this negative relationship, with darker polluted areas are more heavily populated by lighter red dots (schools with a lower percentage of SIMD quintile 1 students).

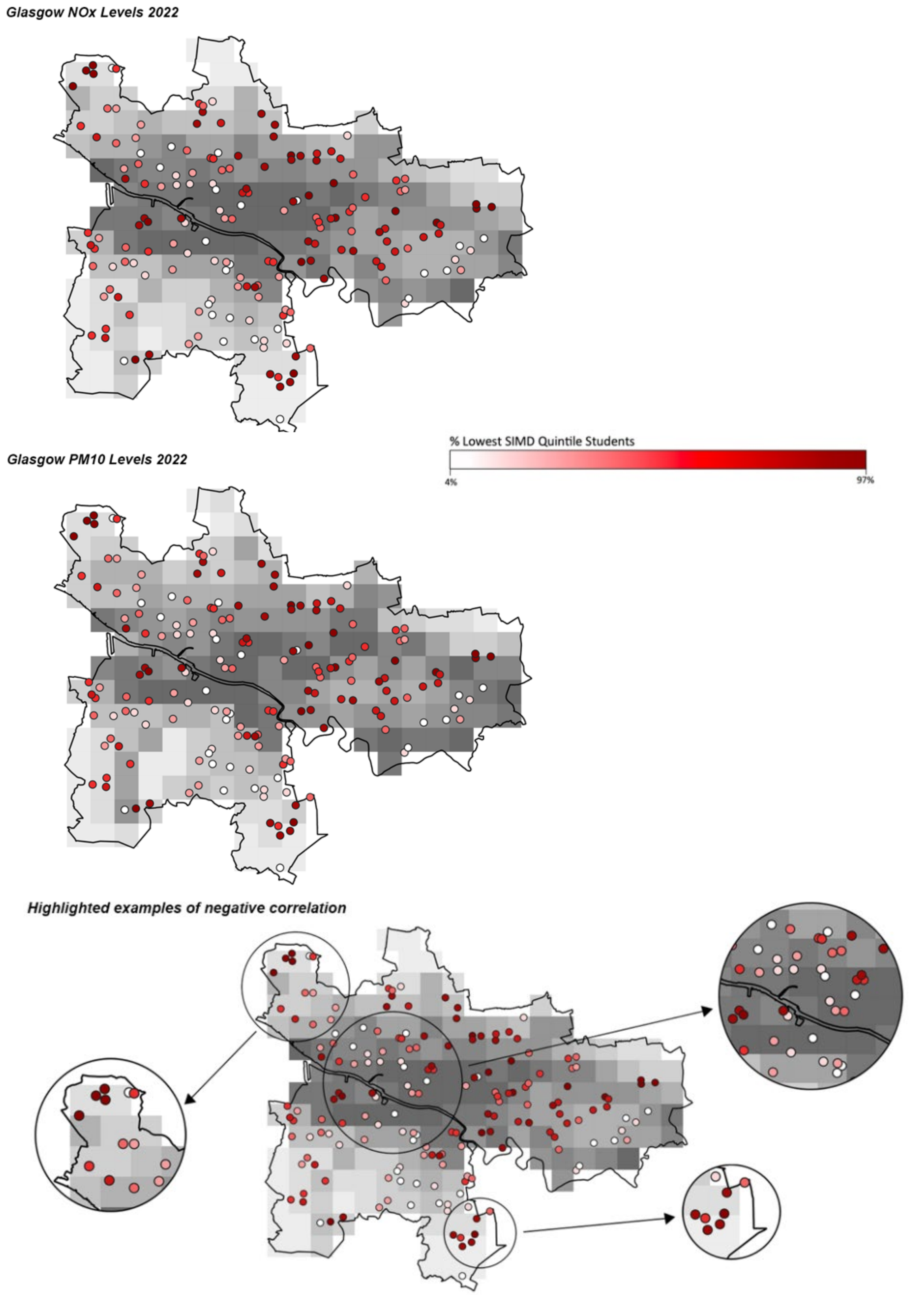
Conducting a comparison analysis on air pollution levels between schools with the highest and lowest percentages of SIMD Quintile 1 students shows the following:

Table 4: comparison analysis of quintile 1 students and pollution levels

Schools with…	*Average NOx µg/m³*	*Average PM2.5 µg/m³*
44% or less SIMD Quintile 1 students	17.21	5.26
82% or more SIMD Quintile 1 students	15.12	5.15
Difference of average pollutant levels	-2.09	-0.11
% Difference of average pollutant levels	-13.79% higher	-2.12% higher

This analysis shows that in 2022, schools with a higher percentage of Quintile 1 students experienced ***lower*** average levels of NOx and PM2.5 emissions compared to schools with a lower percentage of Quintile 1 students.

Figure 3: Percentage of Lowest SIMD Quintile Students Per School Mapped Against Air Pollution Levels



(Scottish Government, 2021; 2022)

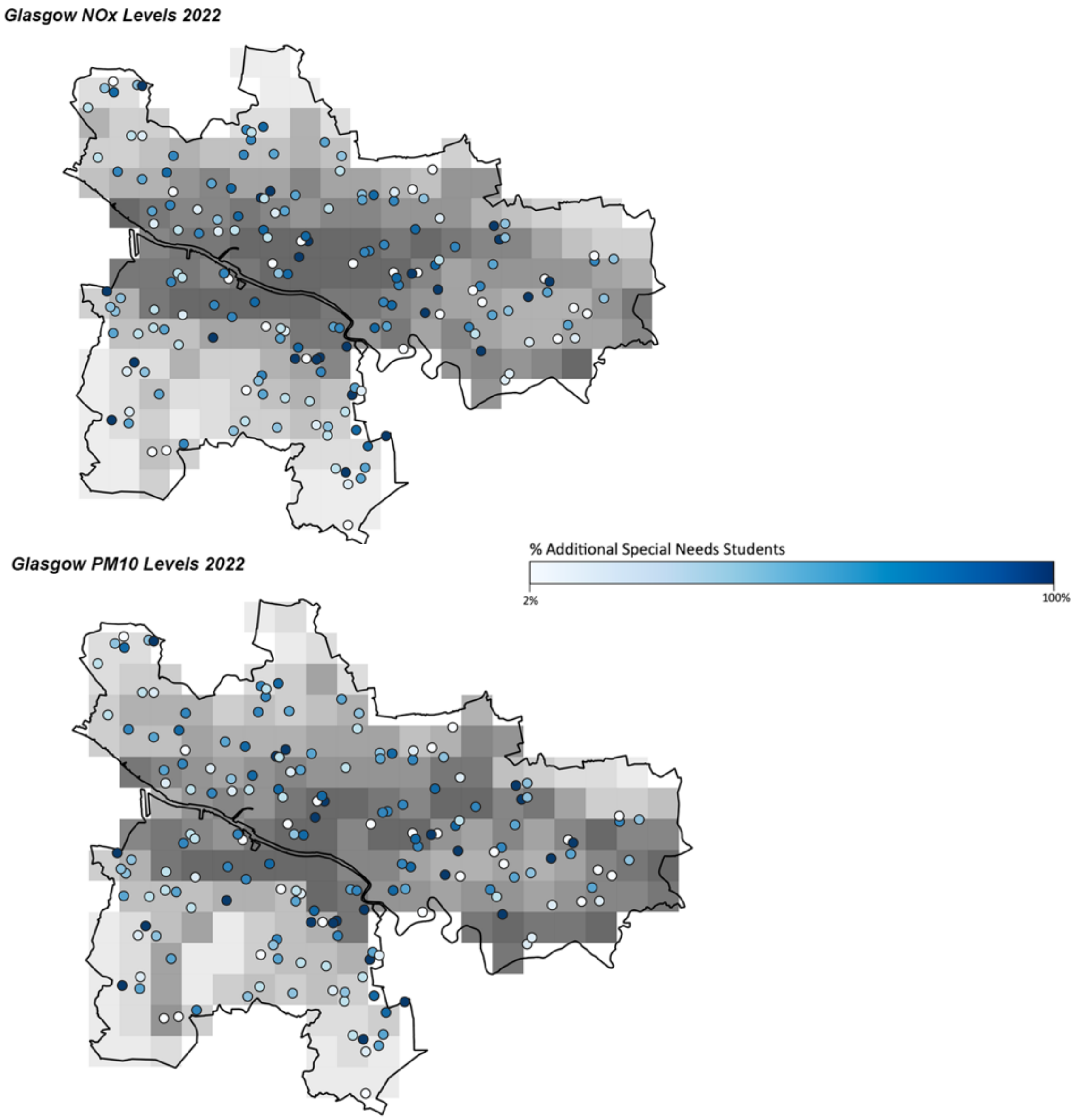
Air Pollution and Additional Special Needs in Glasgow Schools

A neutral (positive but low) correlation is observed between the percentage of students with additional special needs within a school and the level of air pollution.

Schools in figure 4 are now represented by dots of a blue gradient, with the darker blue dots representing schools with a higher percentage of additional special needs students and the lighter blue dots being schools of a lower percentage.

Figure 4 illustrates a neutral relationship, where darker polluted areas are populated by a mix of both darker and lighter blue dots (schools with both higher and lower percentages of additional special needs students).

Figure 4: Percentage of Special Needs Students Per School Mapped Against Air Pollution Levels



(Scottish Government, 2021; 2022)

Once more, a comparison analysis was conducted, this time comparing air pollution levels between schools with the highest and lowest percentages of additional special needs students. The results were as follows:

Table 5: comparison analysis of additional special needs students and pollution levels

Schools with…	*Average NOx μg/m³*	*Average PM2.5 μg/m³*
21% or less special needs students	15.34	5.19
60% or more special needs students	16.95	5.27
Difference of average pollutant levels	1.62	0.09
% Difference of average pollutant levels	9.53% higher	1.67% higher

This analysis shows that in 2022, schools with a higher percentage of additional special needs students experienced higher average levels of NOx and PM2.5 emissions compared to schools with a lower percentage of additional special needs students.

Conclusion

This report highlights the disparities in air quality experienced by different socio-economic groups in Glasgow's schools. The positive correlation between ethnic minority student populations and higher pollution levels underscores a need for targeted interventions to address environmental inequalities. The unexpected negative correlation with deprivation levels suggests that socio-economic geography and urban planning factors may play a crucial role in determining air quality, warranting further investigation. Meanwhile, the correlation with additional special needs students, while neutral, calls for protective measures to shield this increasingly vulnerable group from any potential pollution exposure.

The Glasgow City Council’s Air Quality Action Plan (2024-2029) recognises the importance of monitoring air quality in vulnerable areas, including schools. This report’s findings emphasise the need for continued comprehensive air quality assessments and targeted policies to mitigate pollution exposure for all students, particularly those from ethnic minority backgrounds.

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