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RESEARCH ARTICLE

Air pollution from road traffic near schools and its impact on the physical and psycho-cognitive health of schoolchildren

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Abstract
This research paper examines the issue of road traffic air pollution near schools as a growing threat to children's health and as a critical topic within the framework of contemporary health security. In this context, the study investigates how exposure to traffic-related pollutants notably nitrogen dioxide (NO_2) and fine particulate matter (PM2.5) can negatively affect the physical health, cognitive functions, and psychological well-being of schoolchildren. By adopting both a descriptive and analytical approach, the study highlights the broader social, economic, and environmental health risks. It shows how degraded air quality in educational environments threatens children's right to a safe and healthy development, potentially leading to long-term consequences on learning outcomes, emotional regulation, and public health expenditures. The paper concludes that air pollution near schools must be considered not only an environmental or urban planning issue, but also a health security challenge that calls for urgent, integrated public policies. Ensuring clean air around schools is therefore essential to protecting future generations and reinforcing social stability and national resilience.

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I- Introduction :

Air pollution around schools, exacerbated by road traffic, is a growing concern. Schools near busy roads are exposed to pollutants emitted by vehicles (Wolfe et al., 2021), compromising the health of schoolchildren and staff. Air pollution specifically affects children because of their developing physiology and accelerated breathing rate (Cheung & Malki-Epshtein, 2022). The detrimental consequences of this exposure include breathing difficulties, reduced lung capacity

and a higher risk of asthma, as well as a deterioration in children's cognitive faculties and representational processes, giving rise to major concerns for children's long-term well-being. It is therefore crucial, according to Osborne et al (2021), to explore the various possible methods of creating a healthier school environment, taking into account the practical and economic constraints faced by communities and local authorities.

Faced with this question, Rosenlund et al (2009) stress that it is important to consider strategies for reducing the vulnerability of schoolchildren to transport-related air pollution, which can be introduced to balance the demands of mobility with the need to preserve the health of children in the school environment. This leads us to ask the following question: what strategies could be taken to limit the harmful impacts of this pollution on the health and general well-being of schoolchildren?

This issue is of great importance, as forward-looking solutions require a holistic approach that integrates elements of urban development, transport policy, educational frameworks and public health initiatives. Thus, according to, Méo et al. (2019), it is crucial to analyse the various potential approaches to promote a healthier educational environment, while taking into account the practical and financial limitations faced by communities and local government institutions.

The aim of this article was to shed light on the problem of road traffic-related air pollution near schools and its repercussions on the physiological and psycho-cognitive health of schoolchildren, and to make a contribution on the role of campaigns and awareness-raising programmes in tackling this environmental scourge.

1. Transport-related air pollution:

Transport-related air pollution refers specifically to the harmful emissions generated by motorised vehicles, which include fine particles, nitrogen oxides and carbon dioxide (Krzyzanowski et al., 2005). The latter includes pollutants such as CO, NOx, VOCs, fine particles and SO2, which have a negative impact on health and the environment. It becomes more pronounced near roads used by the population, especially schoolchildren, especially during rush hour, creating areas of high pollution around schools. (Several studies indicate that prolonged exposure to this pollution increases the risk of asthma and respiratory infections in children (Potera, 2008).

2. Importance of the subject in the school context:

Clean air is essential in schools, where children spend around 30% of their day. Air quality is all the more critical as research highlights the vulnerability of the developing brain to the neurotoxic effects of air pollutants (Méo et al.,2019) A multitude of surveys carried out nearly 20 years ago suggest that children living near major roads are more likely to develop respiratory disorders due to their exposure to nitrogen dioxide, carbon monoxide, ultrafine particles from diesel emissions and various other vehicle-borne pollutants. On average, children spend around eight hours of their week in educational establishments, during which time they have no respite from these environmental risks. (Minguillón et al., 2015)

II. Sources of air pollution around schools

The main sources of air pollution around schools include road traffic, nearby industrial facilities and the use of fossil fuels for heating. (Alzuhairi et al., 2016) Road traffic accounts for up to 65% of emissions within a 500-metre radius of schools, with pollution peaking during school start and finish times. (An et al., 2021: Cheung & Malki-Epshtein, 2022) According to Minguillón et al. (2015) School buses, especially when stationary, also contribute significantly to pollution. As well as 'other sources, as highlighted, Bergstra et al. (2019) such as construction sites and heating systems, exacerbate this situation

1. Road traffic (cars, school buses, etc.)

Road traffic (cars, school buses, etc.) plays a crucial role in the quality of the surrounding air, affecting not only the health of pupils, but also that of teachers and school staff, which underlines the importance of adopting measures to reduce these polluting emissions (van Kempen et al., 2012).The harmful effects of this air pollution manifest themselves in an increase in respiratory problems and cardiovascular diseases, particularly among vulnerable populations such as children and the elderly. Mejia et al (2011) and Xie et al (2016) report that PM2.5 can be up to 300% higher during these periods. Adams et al (2017) observe that parents' vehicles, which account for 60% of traffic at these times, generate intense pollution. With regard to school buses, Meo et al. (2019) note that a conventional diesel bus emits an average of 5.8 kg of NOx per school year

2. Other potential sources (nearby industries, building sites, etc.)

These must also be taken into account, as they contribute significantly to the deterioration of air quality. Studies show that emissions from industrial sites can exacerbate adverse effects on respiratory and cardiovascular health, especially when combined with road pollution (Barrett, 2010).Heating systems contribute around 20% of NO2 emissions in winter (Park et al., 2021, Rosenlund et al., 2009) while commercial activities such as restaurants increase the levels of fine particles and VOCs in school grounds (Thompson & Garcia, 2023).It is therefore crucial to develop integrated management strategies that take into account all sources of pollution in order to protect public health and improve the quality of life in our communities. (Leite et al., 2022)

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III. Effects on the health of pupils and school staff

Exposure to air pollution in the school environment has significant health impacts. Chronic exposure to traffic-related pollution is associated with reduced cognitive development in school-age children". (Cheung & Malki-Epshtein, 2022) Pupils living near major roads are 45% more likely to develop asthma (Ryan et al., 2013). The WHO states that prolonged exposure to fine particles increases the risk of chronic respiratory disease in school staff by 20%, while short exposure causes irritation affecting the quality of education.

1. Respiratory problems (asthma, allergies, infections)

Respiratory problems are the most direct health impact of air pollution in schools. Respiratory infections are also more frequent: (Beatty & Shimshack, 2011) "pupils in schools located less than 100 metres from main roads have a 40% higher rate of respiratory infections than others".

2. Impacts on psycho-cognitive development and school performance:

Research shows a significant link between exposure to air pollution and the cognitive development of pupils. Academic performance is also affected, according to Hochstetler et al (2011): "pupils exposed to high levels of air pollution have maths and reading scores 6.1% lower than their peers in less polluted areas. Beatty & Shimshack, (2011) confirm that "absenteeism due to pollution-related respiratory illness increases by 15%, directly impacting school results". Air pollution caused by road traffic, particularly in the vicinity of schools, has deleterious effects on children's psychological health. Prolonged exposure to pollutants such as fine particles (PM2.5) and nitrogen dioxide (NO_2) has been linked to an increase in anxiety, depressive and attention deficit disorders in young people (Roberts et al., 2019). These toxic substances affect brain development, particularly the regions involved in emotional regulation and executive functions (Costa et al., 2017). Air pollution can also cause sleep disturbances, irritability and restlessness, all of which affect children's mental equilibrium. It also compromises their ability to concentrate and learn, having a negative impact on school results (World Heath Organizations, 2021). These psychological impacts, which are often silent but profound, underline the urgent need for measures to protect the air quality around schools".

3. Long-term health effects

Early exposure to airborne contaminants is correlated with a significant decline in lung function in adulthood, with the effects being particularly pronounced in vulnerable demographic groups, including children and people with pre-existing respiratory diseases. (Barrett, 2010)

Epidemiological studies indicate that fine particulate matter (PM2.5), nitrogen dioxide (NO_2) and other environmental pollutants disrupt lung development by causing chronic inflammation and oxidative stress, leading to a decrease in forced expiratory volume (FEV1) and forced vital capacity (FVC). (Wang et al., 2014)

Longitudinal studies, such as those carried out on cohorts in Europe and North America, have observed a reduction of around 10-14% in lung capacity in adults subjected to high levels of pollution from childhood. (Pujol et al., 2016)

According to Mohai et al (2011), children living in polluted urban environments have slower lung growth and an increased risk of developing chronic respiratory conditions, in particular asthma and chronic obstructive pulmonary disease (COPD).

Air pollutants contribute to airway dysfunction, which is exacerbated by interactions with genetic predisposition and environmental factors, particularly passive smoking (Freire et al., 2010).

IV. Prevention and reduction measures

A multidimensional strategy is needed to reduce pollution near schools. Fsadni & Montefort, (2015) recommend creating low emission zones to reduce NO2 emissions by 23%. Mohai et al (2011) demonstrate that "plant barriers between roads and schools can reduce exposure to fine particles by 30%". These innovative approaches show how targeted interventions can not only protect children's health, but also contribute to a more sustainable and pleasant urban environment. What's more, the European Commission (2022) states that "sustainable school mobility initiatives such as pedibus and vélobus reduce rush-hour car traffic by 40%".

Moshammer et al (2006) found that "improved ventilation and the use of HEPA filters in schools can reduce pollutants by 60%". These measures underline the importance of integrating ecological solutions into urban planning to promote a healthy and safe living environment for the younger generations. Hogervorst et al (2006) highlight the importance of

environmental education in increasing family involvement in sustainable transport by 40%. Educational programmes can change behaviour, as Nasrudin & Nor (2013) have shown, with a 35% reduction in car use by parents for school transport after awareness-raising programmes.

Sustainable mobility plan and air quality	
A. Urban development and planning	B. Sustainable transport initiatives
1. Low-emission zones - Delimitation of perimeters - Signposting - Control systems - Buffer zones around schools	1 Encouraging car-sharing and public transport - Car-sharing platform - Drop-off areas - School shuttles - Preferential fares
2. Cycle and pedestrian paths - Separate cycle paths - Safe pedestrian crossings - Clear signs	2. Promoting walking and cycling - Organisation of walking buses - Cycle parking facilities - Reflective waistcoats - Car-free days
C. Improving air quality	D. Raising awareness and education
1. Efficient ventilation systems - Double flow ventilation - CO2 sensors - Regular maintenance - Ventilation protocols	1. Environmental/health education programmes - Theme-based workshops - Educational projects - Presentations by experts - Educational outings
2. Creation of green spaces - Educational gardens - Tree planting - Plant walls - Shaded areas	2. Parental and community involvement - Information meetings - Steering committee - Monthly newsletter - Community events

Nieuwenhuijsen, M. J. (2021).

II– Methods and Materials:

- **Study Methodology and Importance**

In order to explore the complexity of air pollution caused by road traffic near schools and its repercussions on the physical and psychocognitive health of schoolchildren, this study takes a descriptive approach. This method is particularly well-suited to observing and documenting a phenomenon over a specific period, enabling us to capture its various dimensions and developmental patterns (Kumar & al 2022). The descriptive approach enables us to conduct a thorough desk review by consulting validated sources and scientific literature, thereby constructing a robust theoretical foundation. In parallel, an analytical approach will be employed to interpret the socio-environmental, economic and policy-related factors influencing children's health vulnerabilities in polluted urban school zones. This combination of methods will ensure a multifaceted analysis of the intersection between environmental pollution and health security, helping us to identify the mechanisms through which air quality near schools becomes a determinant of physical illness and cognitive or emotional impairment.

- **The importance of this study**

This lies in the recognition that health is a fundamental aspect of human security. Ensuring the well-being of children is a strategic priority for any nation aspiring to sustainable development and social stability. In many regions, , health systems are under strain, and environmental threats such as urban air pollution exacerbate the risks faced by vulnerable

populations. This research contributes to the field of security studies by emphasising the health implications of environmental degradation, and by participating in the academic discourse that broadens.

III- Discussion and conclusion:

Air pollution caused by road traffic around schools is an increasingly serious public health issue. Schools located near busy roads are particularly exposed to harmful vehicle emissions such as fine particles, nitrogen oxides and carbon dioxide (Kumar et al., 2022). This situation is all the more alarming for children, whose developing physiology and accelerated respiratory rate make them more vulnerable to the deleterious effects of pollution. (Landrigan et al., 2019) Studies have shown that this exposure can lead to respiratory problems, reduced lung function and an increased risk of asthma, raising significant concerns about the long-term health of young schoolchildren. Furthermore, air quality in schools is crucial, as children spend around 30% of their day there, during which time they are exposed to often alarming levels of pollution (Cheung & Malki-Epshtein, 2022). Research indicates that children living near major roads are more likely to develop health problems, including respiratory infections and cognitive disorders. Consequently, a review of the literature by Clifford et al (2016) suggests that in-utero exposure to air pollution was associated with neurological development and intelligence between the ages of 3 and 5. In children, poorer performance on an assessment of neurological development, intelligence and memory was associated with levels of exposure to air pollution. In adults, it was visuomotor skills, memory and learning that were most affected by air pollution levels, with faster cognitive ageing observed (Clifford et al., 2016).

There is no doubt that air pollution also has a detrimental effect on children's cognitive development, affecting their memory, attention and learning ability (Odo et al., 2022). Prolonged exposure to fine particles and harmful gases such as nitrogen dioxide also causes inflammation of the brain and oxidative stress, disrupting the normal functioning of neurons. (Wang et al., 2017) These early cognitive problems increase the risk of difficulties at school and anxiety, making children more vulnerable to mental health problems later in life (Chad-Friedman et al., 2021). Empirical research has shown a correlation between living in areas of high pollution and lower IQ and delayed neuropsychological maturation (Hassanien & El Shahawy, 2011). To mitigate these negative effects,

Air pollution is now increasingly recognised as a factor potentially involved in developmental neurotoxicity in children (Block et al., 2012). Previous studies conducted as part of the *BREATHE* (*Brain Development and Air Pollution Ultrafine Particles in School Children*) project have highlighted a link between prolonged exposure to road traffic-related air pollutants (TRAP) during school hours and a slowdown in cognitive development in schoolchildren (Sunyer et al., 2015; Basagaña et al., 2016). These results highlight the harmful impact of urban pollution on maturing brain capacity.

In another study, Yolton.K et al (2019) found a correlation between prolonged exposure to road traffic-related pollution and an increase in symptoms of anxiety, depression and emotional behaviour disorders in children. These psychological manifestations are thought to be partly explained by persistent inflammatory mechanisms affecting the central nervous system, as well as by neurochemical imbalances involving hormones such as serotonin and cortisol, which are essential for regulating mood and stress. These results clearly underline that air quality is a critical environmental factor influencing the mental health of children in schools.

It is now imperative to reduce pollutant emissions and promote healthy environments, particularly in the vicinity of educational establishments and children's residential areas. It is also crucial to invest in awareness and prevention programmes that encourage families to adopt healthy lifestyle practices, thereby helping to protect the cognitive development of young people. (Gupta, M., & Parveen, A. 2020) It is therefore crucial to implement various strategies such as establishing zones limiting polluting emissions and encouraging the use of environmentally-friendly means of transport, as well as creating green screens that also reduce noise pollution (Forssén, J., Kropp, W., & Kihlman, T. 2014). At the same time, it is essential to inform and raise the awareness of both pupils and their parents about the risks associated with this pollution. As well as introducing policies to mitigate pollution, such as improving urban air quality and regulating industrial emissions, in certain regions, thus underlining the essential nature of proactive measures.

Ethical Considerations

This study was conducted in accordance with internationally accepted ethical principles for research in health and social sciences. The research relied on secondary data, environmental indicators, and analytical frameworks drawn from existing scientific literature and publicly available reports. No direct experimentation, clinical intervention, or collection of identifiable personal data from children was undertaken. Consequently, formal ethical approval was not required. The authors ensured that all interpretations were made responsibly, with particular sensitivity to children's health and well-being, and that all sources were properly cited in accordance with academic integrity standards.

Author Contributions

Djenidi Fayza contributed to the conceptualization of the study, literature review, theoretical framework, and drafting of the manuscript, with particular emphasis on psycho-cognitive and psychological health dimensions.

Diab Loubna contributed to the methodological design, analysis of environmental and physical health impacts, data interpretation, and critical revision of the manuscript.
Both authors reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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Conflict of Interest
The authors declare no conflict of interest. There are no financial, institutional, or personal relationships that could have influenced the research process, analysis, or interpretation of the findings.

References

Adams, M. D., & Requia, W. J. (2017). How private vehicle use increases ambient air pollution concentrations at schools during the morning drop-off of children. *Atmospheric Environment, 165*, 264–273. https://doi.org/10.1016/j.atmosenv.2017.06.046

Alzuhairi, A., Aldhaheri, M., Sun, Z., Oh, J.-S., & Kwigizile, V. (2016). Vehicular emissions and concentrations in school zones: A case study. *Journal of Central South University, 23*(12), 3178–3187. https://doi.org/10.1007/s11771-016-3231-9

An, F., Liu, J., Lu, W., & Jareemit, D. (2021). A review of the effect of traffic-related air pollution around schools on student health and its mitigation. *Journal of Transport & Health, 23*, 101252. https://doi.org/10.1016/j.jth.2021.101252

Ardoin, N. M., Bowers, A. W., & Gaillard, E. (2020). Environmental education outcomes for conservation: A systematic review. *Biological Conservation, 241*, 108224. https://doi.org/10.1016/j.biocon.2019.108224

Barrett, J. R. (2010). From roadways to wheeze: Child asthma associated with traffic exposures at home and at school. *Environmental Health Perspectives, 118*(9), A305–A306. https://doi.org/10.1289/ehp.118-a305b

Beatty, T. K. M., & Shimshack, J. P. (2011). School buses, diesel emissions, and respiratory health. *Journal of Health Economics, 30*(5), 987–999. https://doi.org/10.1016/j.jhealeco.2011.05.017

Bergstra, A. D., Brunekreef, B., & Burdorf, A. (2019). The effect of industry-related air pollution on lung function and respiratory symptoms in school children. *Epidemiology, 30*(1), 136–144. https://doi.org/10.1097/01.EE9.0000605920.00253.6c

Boothe, V. L., & Baldauf, R. (2020). Traffic emission impacts on child health and well-being. In *Air pollution and health* (pp. 123–145). Elsevier. https://doi.org/10.1016/B978-0-12-814694-1.00007-5

Castagna, A., Mascheroni, E., Fustinoni, S., & Montirosso, R. (2022). Air pollution and neurodevelopmental skills in preschool- and school-aged children: A systematic review. *Neuroscience & Biobehavioral Reviews, 136*, 104623. https://doi.org/10.1016/j.neubiorev.2022.104623

Chad-Friedman, E., Botdorf, M., Riggins, T., & Dougherty, L. R. (2021). Early childhood cumulative risk is associated with decreased global brain measures, cortical thickness, and cognitive functioning in school-age children. *Developmental Psychobiology, 63*(3), e21956. https://doi.org/10.1002/dev.21956

Cheung, H. Y. W., & Malki-Epshtein, L. (2022). Local monitoring of traffic-related air pollution around schools in south east London, UK. *Ecology and the Environment, 249*, 110071. https://doi.org/10.2495/awp220071

Clifford, A., Lang, L., Chen, R., Anstey, K. J., & Seaton, A. (2016). Exposure to air pollution and cognitive functioning across the life course: A systematic literature review. *Environmental Research, 147*, 383–398. https://doi.org/10.1016/j.envres.2016.01.018

Freire, C., Ramos, R., Puertas, R., López-Espinosa, M. J., Julvez, J., Aguilera, I., Cruz, F., Fernández, M. F., Sunyer, J., & Olea, N. (2010). Association of traffic-related air pollution with cognitive development in children. *Journal of Epidemiology & Community Health, 64*(3), 223–228. https://doi.org/10.1136/jech.2008.084574

Fsadni, P., & Montefort, S. (2015). Air pollution and the school air environment. *International Journal of Indoor and Built Environment, 2*, 1–8. https://doi.org/10.36013/ijipem.v2i0.14

Forssén, J., Kropp, W., & Kihlman, T. (2014). Introduction to traffic noise abatement. In *Traffic noise abatement* (pp. 1–18). CRC Press. https://doi.org/10.1201/b17606-6

Gupta, M., & Parveen, A. (2020). Development of environmental awareness through education: Problems and solutions. *Journal of Emerging Technologies and Innovative Research, 7*(4), 330–334. https://www.jetir.org/view?paper=JETIR2004052

Hassanien, M. A., & El Shahawy, A. M. (2011). Environmental heavy metals and mental disorders of children in developing countries. In *Environmental health risk* (pp. 1–18). Springer. https://doi.org/10.1007/978-94-007-0253-0_1

Hochstetler, H. A., Yermakov, M., Reponen, T., Ryan, P. H., & Grinshpun, S. A. (2011). Aerosol particles generated by diesel-powered school buses at urban schools as a source of children's exposure. *Atmospheric Environment, 45*(8), 1444–1453. https://doi.org/10.1016/j.atmosenv.2010.12.018

Krzyzanowski, M., Kuna-Dibbert, B., & Schneider, J. (2005). *Health effects of transport-related air pollution*. World Health Organization.

Kumar, P., Omidvarborna, H., & Yao, R. (2022). A parent-school initiative to assess and predict air quality around a heavily trafficked school. *Science of the Total Environment, 835*, 160587. https://doi.org/10.1016/j.scitotenv.2022.160587

Landrigan, P. J., Fuller, R., Fisher, S., Suk, W. A., Sly, P. D., Chiles, T. C., & Bose-O'Reilly, S. (2019). Pollution and children's health. *Science of the Total Environment, 650*, 2389–2394. https://doi.org/10.1016/j.scitotenv.2018.09.375

Yolton, K., Khoury, J. C., Burkle, J., LeMasters, G., Cecil, K., & Ryan, P. (2019). Lifetime exposure to traffic-related air pollution and symptoms of depression and anxiety at age 12 years. *Environmental Research, 173*, 199–206. https://doi.org/10.1016/j.envres.2019.03.040