



MADRID

**inter.noise 2019**

June 16 - 19

NOISE CONTROL FOR A BETTER ENVIRONMENT

## **Exposure To Road Traffic Noise And Cognitive Trajectories In Schoolchildren**

**Foraster, Maria<sup>1</sup>**

**ISGlobal, Barcelona, Spain**

**Universitat Pompeu Fabra (UPF)**

**CIBER Epidemiología y Salud Pública (CIBEREsp)**

**Dr. Aiguader 88, 08003 Barcelona, Spain**

**Esnaola, Mikel<sup>2</sup>**

**ISGlobal, Barcelona, Spain**

**Universitat Pompeu Fabra (UPF)**

**CIBER Epidemiología y Salud Pública (CIBEREsp)**

**Dr. Aiguader 88, 08003 Barcelona, Spain**

**García-Esteban, Raquel<sup>3</sup>**

**ISGlobal, Barcelona, Spain**

**Universitat Pompeu Fabra (UPF)**

**CIBER Epidemiología y Salud Pública (CIBEREsp)**

**Dr. Aiguader 88, 08003 Barcelona, Spain**

**López-Vicente, Mónica<sup>4</sup>**

**ISGlobal, Barcelona, Spain**

**Universitat Pompeu Fabra (UPF)**

**CIBER Epidemiología y Salud Pública (CIBEREsp)**

**Dr. Aiguader 88, 08003 Barcelona, Spain**

**Rivas, Ioar<sup>5</sup>**

**MRC-PHE Centre for Environment and Health, Environmental Research Group,  
King's College London**

**Strand, London WC2R 2LS, England, United Kingdom**

**Sunyer, Jordi<sup>6</sup>**

**ISGlobal, Barcelona, Spain**

**Universitat Pompeu Fabra (UPF)**

**CIBER Epidemiología y Salud Pública (CIBEREsp)**

**IMIM-Parc Salut Mar**

**Dr. Aiguader 88, 08003 Barcelona, Spain**

## ABSTRACT

We studied the association between long-term exposure to road traffic noise and schoolchildren's cognitive development. We followed-up a population-based sample of 2715 children aged 7-10 years from 39 socioeconomically paired schools in Barcelona (Catalonia, Spain). Children underwent computerized cognitive tests 4 times during one year (n = 10,112) for working memory (2-back task, detectability), superior working memory (3-back task, detectability), and inattentiveness (Attention Network Task, hit reaction time standard error). Traffic-related noise and air pollution were measured indoors and outdoors at schools, at the start of the school year and 9 months later. Noise was measured with a type II sound level meter using standard protocols to obtain long-term A-weighted average levels (LAeq, in dB). We obtained individual estimated indoor noise levels correcting for classroom orientation and classroom change between years. We calculated cognitive development trajectories adjusted for relevant confounders, including air pollution. Exposure to road traffic noise outdoors at schools was consistently associated with smaller working memory (2-back and 3-back) and greater inattentiveness trajectories in children. Exposure to road traffic noise in classrooms was only associated with inattentiveness. Associations were robust to all adjustment sets. Children exposed to greater road traffic noise at schools may have slower cognitive development.

**Keywords:** Noise, Children, Neurodevelopment  
**I-INCE Classification of Subject Number:** 63

## 1. INTRODUCTION

Road traffic noise is the most prevalent noise source in EU and it represents a worldwide public health concern<sup>1</sup>. An important proportion of the research regarding the health effects of noise relates to large epidemiological studies in adults, which have provided strong evidence for the association of road traffic noise with annoyance, sleep disturbance and cardiovascular disease<sup>2</sup>. However, less is known about children's health. Childhood is a vulnerable period for brain development that could be affected by external environmental factors that interfere with such processes<sup>3</sup>, such as noise. Previous longitudinal and intervention studies have already observed associations between exposure to aircraft noise and impaired cognitive development in schoolchildren, however lower quality evidence exists for road traffic noise and the impact on cognitive executive functions has been addressed in few studies and remains unclear.<sup>4</sup>

Moreover, traffic is not only a source of noise but also of **air pollution**, which has also been related to cognitive impairment in children.<sup>5</sup> However, not all studies were able to consider traffic-related air pollution as a potential confounding factor.<sup>4</sup>

In the framework of the BRain dEvelopment and Air polluTion ultrafine particles in scHool childrEn project (BREATHE) in Barcelona, Spain, we studied the association between long-term exposure to road traffic noise and schoolchildren's cognitive development, in specific, with working memory and inattention.

---

<sup>1</sup> [maria.foraster@isglobal.org](mailto:maria.foraster@isglobal.org)

<sup>2</sup> [mikel.esnaola@isglobal.org](mailto:mikel.esnaola@isglobal.org)

<sup>3</sup> [raquel.garcia@isglobal.org](mailto:raquel.garcia@isglobal.org)

<sup>4</sup> [monica.lopez@isglobal.org](mailto:monica.lopez@isglobal.org)

<sup>5</sup> [ioar.rivas\\_lara@kcl.ac.uk](mailto:ioar.rivas_lara@kcl.ac.uk)

<sup>6</sup> [jordi.sunyer@isglobal.org](mailto:jordi.sunyer@isglobal.org)

## **2. METHODOLOGY**

### **2.1 Study design and sample**

BREATHE is a cohort study that was conducted between years 2012 and 2013 in Barcelona (Catalonia, Spain). We followed-up a population-based sample of 2715 children aged 7-10 years from 39 schools paired by socio-economic (SES) index and selected at extreme contrasting levels of traffic pollution, therefore also representing contrasting road traffic noise levels.

### **2.2 Outcome, exposure assessment, and other relevant information**

Children conducted computerized psychometric measurements 4 times during one school year to obtain a trajectory of cognitive development (n= 10,112).

We assessed working memory (2-back task, detectability), superior working memory (3-back task, detectability), and inattentiveness (Attention Network Task, hit reaction time standard error).

Traffic-related noise and air pollution were measured indoors and outdoors at schools, at the start of the school year and 9 months later. Noise was measured with a CESVA® S160 class II sound level meter using standard protocols to obtain long-term A-weighted average levels (LAeq, in dB). We obtained indoor noise levels in all classrooms by correcting for classroom orientation and change between years.

We also collected questionnaire-based sociodemographic and life-style characteristics of the child and/or the parents and information about the child's residence.

### **2.3. Statistical analyses**

We performed linear mixed effects models adjusted for age, sex, maternal education, neighbourhood socioeconomic index at home, air pollution outdoors (for outdoor road traffic noise) or indoors (for indoor road traffic noise) with school and individual nested as random effects and an interaction term between the exposure (i.e. noise) and age to calculate trajectories.

## **3. RESULTS**

Between the first and fourth visits, children's mean age was between 8.5 years and 9.4 years, respectively. During this period, working memory increased and inattention decreased, as expected.

The correlation between outdoor and indoor noise levels was low (Spearman's  $r = 0.32$ ). The highest correlations were observed between outdoor traffic-related air pollutants and outdoor noise measured at street level ( $r$  range: between 0.64 and 0.72).

Exposure to road traffic noise outdoors at schools was consistently associated with smaller working memory trajectories (2-back and 3-back) and with greater inattentiveness trajectories in children. E.g., in preliminary analysis, road traffic noise outdoors was associated with -7.51 points (95%CI: -11.1; -3.91) in 3-back detectability (numbers). Exposure to road traffic noise in classrooms was associated with inattentiveness. Associations were robust to all adjustment sets.

## **4. CONCLUSIONS**

Children exposed to road traffic noise at schools may have slower cognitive development.

## 5. ACKNOWLEDGEMENTS

We acknowledge all the families and schools participating in the study for their altruism. We also acknowledge Xavier Mayoral, who did the technical development of the  $n$ -back test; Cecilia Persavento, Judit Gonzalez, Laura Bouso, and Pere Figueras contributed to the field work.

The research leading to these results has received funding from the European Research Council under the ERC Grant Agreement number 268479 – the BREATHE project. Maria Foraster is supported by a personal Spanish fellowship Juan de la Cierva-Incorporación.

## 6. REFERENCES

1. European Environment Agency. (Publications Office, 2014).
2. Basner, M. et al. *The Lancet* 383, 1325–1332 (2014).
3. Rice, D. & Barone, S. *Environ. Health Perspect.* 108, 511–533 (2000).
4. Clark and Paunovic, *Int. J. Environ. Res. Public Health*, 15(2), 285 (2018)
5. Sunyer, J. et al. *PLoS Med.* 12, e1001792 (2015).