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Short-term association between environmental factors and hospital admissions due to dementia in Madrid

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ABSTRACT

Background: Spain has one of the highest proportions of dementia in the world among the population aged 60 years or over. Recent studies link various environmental factors to neurocognitive-type diseases. This study sought to analyse whether urban risk factors such as traffic noise, pollutants and heat waves might have a short-term impact on exacerbation of symptoms of dementia, leading to emergency hospital admission.

Material and methods: We conducted a longitudinal ecological time-series study, with the dependent variable being the number of daily dementia-related emergency (DDE) hospital admissions to Madrid municipal hospitals (ICD-10 codes 290.0–290.2, 290.4–290.9, 294.1–294) from 01 to 01-2001 to 31-12-2009, as obtained from the Hospital Morbidity Survey (National Statistics Institute). The measures used were as follows: for noise pollution, Leqd, equivalent diurnal noise level (from 8 to 22 h), and Leqn, equivalent nocturnal noise level (from 22 to 8 h) in dB(A); for chemical pollution, mean daily NO2, PM2.5, PM1 as provided by the Madrid Municipal Air Quality Monitoring Grid; and lastly, maximum daily temperature (°C), as supplied by the State Meteorological Agency. Scatterplot diagrams were plotted to assess the type of functional relationship existing between the main variable of analysis and the environmental variables. The lags of the environmental variables were calculated to analyse the timing of the effect. Poisson regression models were fitted, controlling for trends and seasonalities, to quantify relative risk (RR).

Results: During the study period, there were 1175 DDE hospital admissions. These admissions displayed a linear functional relationship without a threshold in the case of Leqd. The RR of DDE admissions was 1.15 (1.11–1.20) for an increase of 1 dB in Leqd, with impact at lag 0. In the case of maximum daily temperature, there was a threshold temperature of 34 °C, with an increase of 1 °C over this threshold posing an RR of 1.19 (1.09–1.30) at lag 1. The only pollutant to show an association with DDE hospital admissions was O3 at lag 5, with an RR of 1.09 (1.04–1.15) for an increase of 10 μg/m^3

Conclusions: Diurnal traffic noise, heat waves and tropospheric ozone may exacerbate the symptoms of dementia to the point of requiring emergency admission to hospital. Lowering exposure levels to these environmental factors could reduce dementia-related admissions in Madrid.

1. Introduction

Spain has one of the highest proportions of dementia in the world in the population aged 60 years or over (OECD, 2013). According to this same study, 6.3% of Spaniards over the age of 60 suffer from some degree of dementia; only France (6.5%) and Italy (6.4%) rank ahead of Spain. The mean of OECD countries is eight-tenths lower than that of Spain (5.5%). Also situated above this mean are some Northern European countries, such as Sweden (6.3%) and Norway (6.2%), as well as some of the world's leading economic powers, namely, the USA, United Kingdom and Japan (all three with 6.1%) and Germany (5.8%) (OECD, 2013).

With respect to the possible relationship between environmental factors and this disease, many papers have been published in recent years which report a link between long-term exposure to traffic-related pollution and the presence of these factors in various neurological disorders. Most of these studies focus on the effect that chemical air pollution -in the form of particles (Ranft et al., 2009; Weuve et al., 2012), ozone levels (Chen and Schwartz, 2009) and NO_2 (Oudin et al., 2016), others have failed to find this association (Gatto et al., 2013). A recent review of the literature on the effects of air pollution on cognitive and psychological function in adults (Tzivian et al., 2015) concluded that 15 studies had reported effects of air pollution on a series of factors

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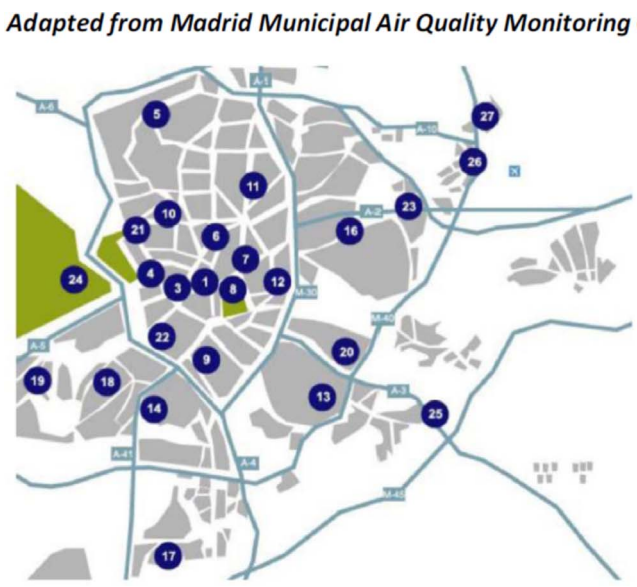

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04	PL. DE ESPAÑA	MONCLOA	3°42'44,40"	40°25'26,37"
05	BARRIO DEL PILAR	FUENCARRAL	3°42'41,55"	40°28'41,62"
06	PL. DR. MARAÑON	CHAMBERI	3°41'27,00"	40°26'15,39"
07	PL. M. SALAMANCA	SALAMANCA	3°40'49,19"	40°25'47,81"
08	ESCUELAS AGUIRRE	SALAMANCA	3°40'56,35"	40°25'17,63"
09	PL. LUCA DE TENA	ARGANZUELA	3°41'36,35"	40°24'07,68"
10	CUATRO CAMINOS	CHAMBERI	3°42'25,66"	40°26'43,95"
11	AV. RAMÓN Y CAJAL	CHAMARTÍN	3°40'38,47"	40°27'05,30"
12	PL. MANUEL BECERRA	SALAMANCA	3°40'06,71"	40°25'43,70"
13	VALLECAS	PUENTE VALLECAS	3°39'05,48"	40°23'17,34"
14	PL. FDEZ. LADREDA	USERA	3°42'59,71"	40°23'06,28"
15	PLAZA DE CASTILLA	TETUÁN-CHAMARTÍN	3°41'19,29"	40°28'05,73"
16	ARTURO SORIA	CIUDAD LINEAL	3°38'21,24"	40°26'24,17"
18	GENERAL RICARDOS	CARABANCHEL	3°43'54,60"	40°23'41,20"
19	ALTO EXTREMADURA	LATINA	3°44'30,83"	40°24'28,29"
20	AV. DE MORATALAZ	MORATALAZ	3°38'43,03"	40°24'28,64"
21	ISAAC PERAL	MONCLOA	3°43'04,54"	40°26'24,51"
22	PASEO DE PONTONES	ARGANZUELA	3°42'46,56"	40°24'22,95"
23	C/ ALCALÁ (Final)	SAN BLAS	3°36'34,62"	40°26'55,44"
24	CASA DE CAMPO	MONCLOA	3°44'50,44"	40°25'09,68"
25	SANTA EUGENIA	VILLA VALLECAS	3°36'09,18"	40°22'44,48"
26	URB. EMBAJADA	BARAJAS	3°34'48,42"	40°27'33,56"
27	BARAJAS PUEBLO	BARAJAS	3°34'48,10"	40°28'36,94"

Fig. 1. Madrid Municipal Air quality Monitoring Grid..

which affect parameters linked to cognitive function, thus showing that there is relevant scientific evidence to associate air pollution with mental health.

Another factor closely related with traffic exposure is acoustic pollution, since 80% of noise in a large city is due to such traffic (Díaz and Linares, 2015). However, studies that link noise to mental health indicators are less numerous than those addressing chemical air pollution. At an individual level, it has been suggested that the discomfort caused by noise as an obstacle to optimal physiological and mental function, may have an impact on quality of life (WHO, 2011). This would lead to an increase in psychological stress which, depending on the time of duration, might in turn give rise to a different effect, i.e., acute exposure can cause psychological stress, but chronic exposure can bring about chronic psychological stress (Rylander, 2004) and, by extension, a worse quality of life, to the point of causing depression. A case-control study undertaken in Sweden in 2007 (Persson et al., 2007) linked traffic noise to treatment of psychiatric problems such as anxiety. Similarly, a later study conducted in Switzerland in 2009 (Brand et al., 2009), associated traffic noise with anxiety disorders and depressive symptoms. More recently, a study was carried out in France, which linked nocturnal noise to the use of anxiolytics (Bocquier et al., 2013).

Owing to the design of the above studies, the effects of acoustic and chemical pollution were generally considered independently of each other. Only the study by Persson et al. (2007) analysed the effects of both pollutants simultaneously, and concluded that there might be synergisms between the two whereby one boosted the effects of the other.

The hypothesis of our study was to ascertain whether, urban-type environmental factors, such as air pollution and/or traffic noise, might be present in the short term in the exacerbation of symptoms of a mental disease such as dementia, leading to emergency admission to hospital of persons already suffering from the disease. To reach the objective an ecological time series design has been performed, using data for chemical an acoustic pollution in Madrid City.

2. Methods

2.1. Study population

The city of Madrid is a densely populated metropolitan area situated in the central region of Spain. In the period 2001–2009, it had a mean population of 3,116,897 and of this total, 754,005 persons (24.2%) were aged 60 years or over (INE, 2015). The diagnoses studied came within the psychosis group of the International Classification of Diseases 9th Revision (ICD-9), under the head of organic psychotic conditions (Codes 290-294). The following codes were excluded from analysis: mental retardation (Code 317-319); alcohol-induced mental disorders (Code 291.0); and drug-induced mental disorders (Code 292.0).

2.2. Outcomes

1. Number of Daily Dementia-related Emergency (DDE) admissions to municipal hospitals in Madrid, as drawn from the Hospital Morbidity Survey (HMS) compiled by the National Statistics Institute (*Instituto de Estadística/INE*). We considered emergency admissions of persons with diagnosis of dementia (ICD-9:290-294) in the city of Madrid, from 01 to 01-2001 to 31-12-2009.

2.3. Exposure

As principal independent variables of analysis, we used the data supplied by the Madrid Municipal Air Quality Monitoring Grid (http://www.mambiente.munimadrid.es/), a network that consists of 27 urban background stations spread across the city, which monitors chemical air pollutants and environmental noise data in real time (Fig. 1).

1. Measures of acoustic pollution: Leqd, equivalent diurnal noise level (from 8 to 22 h) in dB(A), and Leqn, equivalent nocturnal noise level (from 22 to 8 h) in dB(A).
2. Measures of chemical pollution: daily mean concentrations ($\mu g/m^3$) of particulate matter less than 2.5 and 10 μm in diameter ($PM_{2.5}$ and PM_{10}), tropospheric ozone (O_3) and nitrogen dioxide (NO_2). All measurements were made using the gravimetric method or an equivalent method (beta-attenuation).

To estimate daily mean levels of noise and chemical air pollutants, each monitor's daily level was averaged for that monitor, and a city-wide average was then calculated from all monitors for any given day. Furthermore, no specific validation was performed within the project to assess the representativeness of spatial variability in air pollutants; an ecological exposure was used, as is common in most time-series studies.

As atmospheric variables of control, we considered the maximum daily temperature (°C), as furnished by the State Meteorological