Exposure to particulate matter and risk of conversion from mild cognitive impairment to dementia: a cohort study in a Northern Italy population

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Background

Exposure to air pollutants such as inhalable particulate matter has been linked to increased risk of chronic disease including neurodegenerative diseases, such as Alzheimer's dementia. In this study, we aimed to evaluate the effect of long-term exposure to outdoor air pollution, and specifically to particulate matter ≤10 µm (PM_{10}), on the risk of dementia in a cohort of subjects with mild cognitive impairment.

Methods

We recruited 53 subjects newly-diagnosed with mild cognitive impairment of non-vascular origin and residing in the Modena and Reggio Emilia provinces, Northern Italy. Using CALINE4 air pollution dispersion model, we assessed exposure to outdoor PM_{10} from motorized traffic at subjects' residence. We investigated the relation of these levels to subsequent onset of dementia, using a Cox proportional hazards model by computing hazard ratio (HR) and 95% confidence interval (CI) according to fixed categories of PM_{10} exposure. We also assessed dementia risk in relation and annual average PM_{10} levels using restricted cubic splines with three knots (10, 50 and 90 percentiles). In both analyses we adjusted for sex, age at entry, and educational attainment level.

Results

During a median follow-up of 42 months, 19 participants developed Alzheimer's dementia, 3 frontotemporal dementia and 2 Lewy body dementia. Baseline PM_{10} exposure levels were 9.6 µg/m³ on average. Using PM_{10} levels below 5 µg/m³ as reference, we found a dose-response increase in any dementia risk with HR of 1.04 (95% CI 0.41-2.66) at 5-10 µg/m³, 1.32 (95% CI 0.36-4.92) at 10-20 µg/m³, and 1.38 (95% CI 0.14-13.13) above 20 µg/m³, respectively.

Table 1. Baseline characteristics of all study subjects diagnosed with mild cognitive impairment, and divided by subsequent diagnosis during follow-up.

	Baseline MCI	Converted to dementia	Remaining MCI
	N (%)	N (%)	N (%)
All subjects	53 (100)	24 (100)	29 (100)
Sex			
Men	28 (52.8)	11 (45.8)	17 (58.6)
Women	25 (47.2)	13 (54.2)	12 (41.4)
Age at entry			
Mean (SD)	66.3 (7.5)	66.3 (7.1)	66.2 (8.2)
< 65 years	22 (41.5)	8 (33.3)	14 (48.3)
≥ 65 years	31 (58.5)	16 (66.7)	15 (51.7)
Education			
< 8 years	18 (34.4)	7 (29.2)	11 (37.9)
8 - 12 years	15 (28.3)	7 (29.2)	8 (27.6)
≥ 12 years	20 (37.7)	10 (41.6)	10 (34.5)
PM_{10} levels			
Mean (SD) µg/m³	9.7 (6.5)	11.0 (7.7)	8.6 (5.1)
< 5 µg/m³	28 (52.8)	11 (45.8)	17 (58.6)
5 - 10 µg/m³	19 (35.9)	9 (37.5)	10 (34.5)
10 - 20 µg/m³	5 (9.4)	3 (12.5)	2 (6.9)
≥ 20 µg/m³	1 (1.9)	1 (4.2)	0 (0.0)

Abbreviations: MCI, mild cognitive impairment; N, number of subjects; PM, particulate matter; SD, standard deviation.

Conclusions

Our results suggest that the low exposure to particulate matter emitted by motorized vehicles increases the risk of conversion from mild cognitive impairment to dementia, though the low number of study participants suggests caution in the interpretation of these findings.

Table 2. Odds ratio (OR) and 95% confidence interval (CI) of ALS risk in relation to exposure to outdoor air pollution.

	HR	(95% CI)
	Model 1	
PM_{10} categories		
< 5 µg/m³	1.00	-
5 - 10 µg/m³	1.03	(0.43 - 2.50)
10 - 20 µg/m³	1.40	(0.39 - 5.05)
≥ 20 µg/m³	1.91	(0.24 - 15.03)
10 µg/m³ continuous increase	1.34	(0.61 - 2.96)
	Model 2	
PM_{10} categories		
< 5 µg/m³	1.00	-
5 - 10 µg/m³	1.04	(0.41 - 2.66)
10 - 20 µg/m³	1.32	(0.36 - 4.92)
≥ 20 µg/m³	1.38	(0.14 - 13.13)
10 µg/m³ continuous increase	1.24	(0.54 - 2.82)

Model 1: crude model; Model 2: adjusted for age at entry, sex, and years of education; PM, particulate matter.
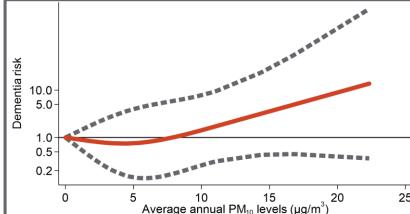

Figure 1. Spline regression analysis of dementia risk according to increasing annual average PM_{10} levels (µg/m³) adjusting for sex, age at entry and educational attainment.

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