Exposure to urban pollutants among traffic police in Paris

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Traffic police workers are at high risk of exposure to air pollution. Despite the increasing number of motor vehicles in Paris and its suburban area, no monitoring of airborne pollutants has been made on urban police since the last decade (Bugajny et al, 1999.).

Exposure assessment

We conducted a survey to evaluate individual levels of main urban pollution indicators with recognized sanitary effects including nitrogen dioxide (NO_2), benzene, toluene, carbon monoxide (CO) and particulate matter ($PM_{2,5}$) among traffic police employees in relation to the ambient concentrations of the same pollutants. Formaldehyde and acetaldehyde were included in the analysis as indicators of indoor pollution.

One highly exposed occupational group among the Paris City Police Force was selected. The study population consisted of 23 healthy employees recruited from the Ring Road police squad (RRS). This department comprises 164 police officers who control the traffic on the Inner and Outer Ring Roads surrounding the centre of the city, seven days a week around the clock. Thus, RRS police officers are constantly exposed to the air pollution inside and outside their cars. Parisian ring roads are among the most congested urban roadways of Europe with a traffic density of 1,300 000 vehicles per day, and a permanent cars overcrowding of 300,000. Total ring road length is estimated at 70km. A number of 2063 car accidents were reported on the Parisian ring road with a total of 7176 police interventions in 2009. Subjects engaged in indoor activities inside the two departments (i.e. administrative and bureaucratic duties) with lower levels of exposure were equipped in parallel with air samplers and were used as control groups (non-exposed policemen). Participants underwent a medical check-up including physical examination and pulmonary function tests. Age, weight, height, and systemic blood pressure were recorded.

The measurements were realized in contrasted situations such as morning, afternoon and nights shifts in summer and in winter. The average temperature varied from 2.7° to 30.2°C. A total of 994 results were validated, 611 for the exposed and 383 for the non-exposed (control) subjects.

The sampling and analysis methods used in this study to evaluate individual levels are presented in Table 1. Continous measurements, active and diffusive sampling methods were carried out.

Table 1. Sampling and analysis methods.

Pollutants	Sampling method	Analysis method
Benzene and Toluene	Active sampling	CPG - FID
Fine particles $PM_{2,5}$	Active sampling	Gravimetry
Nitrogen dioxide	Diffusive sampling	Griess Saltzman method
Formaldehyde and acetaldehyde	Active sampling	HPLC & UV spectrophotometry
Carbon monoxide	Continuous	Electrochemical detection

Results

Results obtained for benzene, particulate matter ($PM_{2,5}$), nitrogen dioxide (NO_2) and formaldehyde (HCHO) are presented in Table 2.

Table 2. Pollutants levels expressed in $\mu g.m^{-3}$
(N : number of ratios calculated, E : exposed policemen, NE : non –exposed policemen).

Pollutants		summer			winter		
		N	Median	Range	N	Median	Range
benzene	E	33	2.8	<1.9 - 8.7	30	3.5	<1.9 - 6.4
	NE	16	<1.9	<1.9 - 2.4	17	2.1	<1.9 - 4.9
$PM_{2,5}$	E	18	27	18-46	14	30	<10 - 63
	NE	19	16	<10 - 24	17	18	<10 - 32
NO_2	E	38	150	72 - 320	36	150	74 – 200
	NE	19	76	36 - 110	18	77	44 - 100
HCHO	E	15	8.3	5.0 – 25	18	9.7	6.5 - 17
	NE	19	6.3	4.6 – 9.7	18	8.5	6.1 - 12

Distribution of the ratios between exposed policemen and non-exposed policemen for benzene, particulate matter and NO_2 is presented in Table 3. GEE (generalized estimating equations) model was used to compare the pollutant means between exposed and non-exposed employees taking into consideration the matching (exposed and non-exposed being measured during the same time period) with the Genmod procedure in SAS (Diggle et al., 1994).

Table 3. Ratios between exposed and non-exposed police officers (N : number of ratios calculated).

Pollutants	summer			winter		
	N	Median	range	N	Median	Range
benzene	31	3.1	1.0-6.9	30	1.4	0.45-2.9
$PM_{2,5}$	18	1.7	1.2-3.1	14	1.7	0.91-4.6
NO_2	38	2.1	0.9-3.8	36	1.9	1.1-2.9
HCHO	15	1.4	0.6-2.8	18	1.2	0.74-1.7

For all exposed and control subjects, values obtained for the CO were lower than the detection limit of the individual analyser.

Discussion

Traffic policemen are occupationally exposed to environmental pollutants that are known to be harmful to the health. The personnel the Ring Road police squad (RRS) spend the majority of their working time in or near their cars on pollution Ring-Road spots. Our study findings show that for all pollutants, levels of exposure were significantly higher among traffic than among indoor police workers. This supports the hypothesis that traffic police officers are at major risk of air pollution.

In the exposed group, NO_2 concentrations ranged from 72 and 320 µg/m^3 with a median concentration of 150µg/m³. Fourteen percent of these values obtained for 8 hours were above the WHO recommended hourly threshold of 200 µg/m^3.

$PM_{2.5}$ concentrations varied from 8 to 65µg/m^3 with a median concentration of 30µg/m³. In our study, 68 per cent of exposure values for PM2.5 particles were over 25 µg/m³, the 24-hour WHO threshold for this pollutant. However, it should be noted that for practical reasons these measurements were made during an 8-hour period of time, which makes our results difficult to interpret in the absence of standards.

The present investigation confirms also the significant decrease of carbon monoxide levels observed over the recent years in urban areas. In our study, WHO threshold for 15 minutes (100cm³/m³), 30 minutes (50cm³/m³), 1 hour (25cm³/m³) and 8 hours (10cm³/m³) exposition were all respected.

Table 3 shows the distribution of the ratios for NO_2, particulate matter, benzene and formaldehyde between exposed and non-exposed police employees during the two seasons. The maximum value is obtained for benzene in summer. For NO_2 and $PM_{2.5}$ the distribution of ratio was similar in the summer and the winter seasons. Concerning formaldehyde, distribution of ratio was different with 25% of the ratio below 1.

Exposure to NO_2, $PM_{2.5}$ and benzene in police officers have also been compared with results obtained in the same period by the Parisian air quality survey network. Air quality in Paris-Ile-de France is monitored by AIRPARIF. This non-profit organization approved by the Ministry of Environment has implemented a measurement network for 60 pollutants. Approximately, 20 roadside stations measure vehicle pollution along roads and 40 automatic background stations the ambient pollution far from roads. Regarding this study, the most interesting traffic station is a station located near the Ring Road way (Paris Porte d'Auteuil, Airparif). This comparison indicates that third quartile (Q3) values were higher, more marked for benzene with mean value in exposed policemen were 60% higher than mean value on traffic station. For NO_2 and $PM_{2.5}$, the difference was estimated respectively of fifteen and thirteen per cent.

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